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IT IS UP TO THE CITIES
Says Secretary Ickes

Federal Administrator of Public Works in Address to Conference of Mayors at Chicago Explains the Purposes of the $1,750,000,000 *Program for State and Municipal Projects*

IT IS now largely in the hands of the mayors of our cities to determine whether the Public Works Program will fully serve its purpose in aiding in the economic recovery of the country. Our National Treasury is waiting to be drawn upon for hundreds of millions of dollars for useful public works. The Administration in Washington can approve projects and advance funds necessary to complete them. We have moved and are moving expeditiously, if circumspectly, but there is a point beyond which we cannot go. We can give you money; we can help you to decide what project to undertake; we can assist you with your plant aand your specifications and the letting of your contracts; we can aid you in supervising your work; we can meet the charges of the contractors when they fall due; we can even encourage you to speed up your projects. But we cannot do more than this. We cannot decide for you whether you want public works. We cannot make you borrow money from us on favorable terms. We cannot force you to move any faster than you are willing to move. All we can do is to ask you to "get on your marks! Get set! Go!" You will have to run the race.

The Greatest Pubic Works Opportunity—The Public Works Program, contemplating as it does the expenditure of funds in excess of $1,750,000,000 for state and municipal projects, offers the greatest opportunity for municipal improvement in the history of any country. We are willing to advance you as an outright gift 30 percent of your outlay for labor and material on an approved plan. We ask you to pay for the balance of the project. But we are willing to help you to finance your share. We will advance you the remaining 70 percent upon approved security and by approved security I don't mean that we will be as finicky about the security that you may offer as would be the investment bankers with whom you are accustomed to deal. We will lend you this 70 percent at 4 percent interest and permit you to amortize it over a period not to exceed 30 years.

Here is an opportunity to build necessary and desirable public works on more favorable terms than you have ever had before or than you may ever have again. Do you need new water works, or an extension of your present plant? Do you want a new or improved sewage system? Do you require bridges or viaducts or public buildings or roads or new schools? These things and others you may have on unbelievably generous terms.

But to our surprise, we find that in many parts of the country the Federal Government, in offering a grant of 30 percent and a loan of the balance of 70 percent at 4 percent interest, is being regarded as an ungenerous or even a niggardly stepfather. There is even a chance that some of our municipalities will soon be calling us "Uncle Shylock." It is intimated in some quarters that not only ought we to give 100 percent outright, but that we should turn the money over for unregulated expenditure by the municipalities themselves.

A Wise Policy—In my opinion, the 30-70 policy laid down in the Industrial Recovery Act for the financing of municipal projects is a wise policy. It is wise from several points of view. In the first place, if municipalities will put in their 70 percent of the sum necessary for the project, the Public Works Fund will, necessarily, spread much further and thus provide more employment. In the second place, there will be afforded a basis for helpful cooperation between the municipalities and the Federal Government. In the third place, if municipalities are willing to back their own public works projects to the extent of 70 percent they will thereby assure us that their projects are desirable. Besides they will be contributing to our general recovery program. And last, but not least, a city can accept a 30 percent grant without diminution of pride or self-respect, both of which would be impaired, if not destroyed, if it relied altogether upon the generosity of the Federal Government.

Naturally, the purpose of the Public Works Program is not merely to do work for the sake of doing the work. We want to increase buying power because it is realized that without increasing buying power our recovery program will fail. In this the municipalities are as much interested as the Federal Government.

Two Results by Same Effort—If at the same time that we increase buying power we build useful and socially-desirable public works, we are accomplishing two fine results by the same effort. I need not point out to you that for every hundred thousand men at work on public works projects there are at least an equal number at work back of the lines in saw mills, in steel mills, in factories, in quarries, and on railroads, producing materials and performing services necessary to supply the men on actual projects with what they need for their work. And as these men on the works and back of the lines acquire buying power, they are in a position to increase the buying power of others. They will be buying more clothing. They will be sending their children to school. They will be able to afford more and better food. A new automobile will not be beyond their hopes. They will want to repaint their houses and repair them.

Thus, they will be helping turn the wheels of industry, giving employment to those who in turn will give further employment to others, until the recovery movement will be able to keep moving of its own momentum and the stimulus which we are now ready and willing to provide in the way of public works will no longer be necessary.

Criticism of Minimum Wage Stipulation—Complaints have come to the Public Works Administration from several quarters that the minimum wages stipulated to be paid on public works projects are too high. Those who voice this criticism, as I see it, do not have a proper view of the situation. Our avowed object is to increase buying power. We cannot increase buying power effectively or to any considerable extent if we do not pay enough wages so that people will have more than a mere subsistence income. It does not matter much where the increase in buying power begins. If the workman gets more money than he is now getting, this will shortly benefit other groups. As I have pointed out, he will be in a position to buy more food and more clothing. This will add to the income of the farmer, the merchant, the wholesaler and the manufacturer. If we short-sightedly refrain from increasing buying power for one group because we cannot simultaneously increase all groups proportionately, we will not accomplish our objective and we will all be left in the slough of economic despond. All of us ought to be willing to see the other fellow achieve a legitimate and necessary increase in his income even if we ourselves are not immediately or directly benefited. Our turn will inevitably come.

The farmer has had a substantial lift through the Agricultural Adjustment Act. Business and industry generally will, in due course, feel the stimulus of the increased income that the farmers are earning. If we can now furnish to the laborer employment at wages which will give him even a slight economic surplus, business and industry will necessarily feel the benefit. In my judgment we would be adopting a wrong economic policy if we should keep every one down to a minimum income measured by the requirements of a bare existence. We would resemble a man proposing to run a race but persisting in standing stock still when the starting gun is fired because he doesn't want to put one foot ahead of the other to begin with.

Another Side of Bonding Power Limit—It may be urged in some quarters that the municipalities in many instances have reached the limits of their bonding powers. There are tax strikes on here and there throughout the land. Real estate values have gone off so sharply that the tax yield from the necessarily lower assessed valuations is not sufficient to meet current expenses, let alone interest even at 4 percent on a new municipal obligation. In some instances, teachers and other municipal employees have not been paid for many months as the result, first, of refusal on the part of taxpayers to meet their obligations to the State; and, second, of reduced tax income.

I am familiar with this situation because, for many years, I have been particularly interested in municipal government. But I know that there is another side of this picture. I know that people would be more willing to pay their taxes if they were assured of equitable assessments. I know that they would without grumbling pay on even an inequitable assessment if they felt that their taxes were being wisely and economically expended. There has been waste and inefficiency. Bond issues cheerfully voted for permanent improvements have been drawn upon heavily for political purposes. Public works have been so skimped that, in many instances, they have not been able to last for the period over which they have been amortized, with the result that people have been called upon to begin anew to pay for improvements before they have finished paying for similar predecessor improvements. Moreover, municipalities, in common with other political entities, have been in some cases reluctant to face the situation imposed by this period of economic distress. Padded pay rolls, excessive salaries, and part-time work for full-time pay have not been unknown in some sections of America.

An Opportunity for Leadership—But the very plight of some of our cities offers a rare opportunity for forthright leadership. I predict that out of this present period of strain and stress a new concept of the duty of the average citizen to his city, a new sense of responsibility on the part of our elected officials, will be born. Already President Roosevelt has sounded the call. Hear what he said recently to a throng of his neighbors at Poughkeepsie, N. Y.:

"We haven't done much to reorganize our local government—what you and I know to be an outworn system built up in the days of the ox cart and unchanged in the days of the automobile.

"Nothing will be done about it unless you make your representatives on the town boards, on the county boards and in the State Legislature do something about it. And if they won't do it, substitute other representatives for them.

"When I say that I am not talking Democratic politics, I am talking straight Dutchess County Americanism."

The President might have added that it is not only in the State of New York that we have, so far as our local governments are concerned "an outworn system built up in the days of the ox cart." I know the same situation exists here in my own State of Illinois. I doubt whether New York or any other State has a more inadequate, cumbersome system of county, township and municipal governments than Illinois can boast. And I suspect that there are few states in the Union where, if a careful study were made with a view to putting local governments on a simple and sensible basis so as to make economical administration possible, astonishing and pleasing economic results from the point of view of the taxpayer could not be achieved. The trouble is that some short-sighted politicians resist any change in local governmental institutions. The more complicated and the more obscure the system, the more befogged is the citizen when he goes to the polls and the greater profit there is in the number of jobs and the emoluments that go with these jobs.

The Public Works Administration Organization—The President did to me the honor of appointing me Administrator of Public Works on July 8, 1933—approximately two and a half months ago. Prior to that time there had been a temporary administration, but that administration, knowing that it was temporary, really never got started. It is fair to say, then, that the Public Works Administration slid off the ways on July 8, 1933. We were confronted with a tremendous task. There was no organization to begin with, except an Administrator and an Advisory Committee composed of certain Cabinet officers and other Government officials. Since it was desired to get as much of the public works fund as we could into circulation at the earliest possible date, we could not proceed in an orderly manner and build up an organization gradually. The peak of our job was at the very beginning. We set about to comb the country for engineers, lawyers and financial experts. This had to be done almost over night. Concurrently, we decided, in the interest of speed and with the idea of decentralizing our work as much as possible, to set up state advisory

committees and regional advisors. We wanted to keep these out of politics. This was no easy task. The pressure to appoint men for partisan reasons or for sinister purposes can be imagined. I think no one will be disposed to dispute my statement that the state advisory committees, the regional advisors, and the state engineers, when named, generally acclaimed throughout the country as appointments of a high order, selected as they were on the basis alone of character, ability and known standing in their various communities.

The sum of approximately $1,600,000,000 has already been allocated by the Public Works Administration. To be sure, several considerable items included in this total were earmarked in the act itself, but even outside of these amounts appropriations have run into the hundreds of millions of dollars and they have been made as expeditiously as has been consistent with a prudent regard for the public welfare. The major portion of these allocations has gone for Federal projects and the reason for this is not far to seek. We knew our own Federal projects. We had our engineers and our staffs ready to turn loose on them. They could be undertaken with a minimum of delay and with an assurance of a lack of waste and misapplication of funds. Moreover, we could authorize these Federal projects while your municipalities were preparing your projects.

Municipal Projects Should Be Got Underway at Once—Latterly, we have been devoting the major part of our attention to municipal projects. We want to get these under way without loss of time. We want them to be as widespread as possible and to provide the maximum of employment.

We are not being technical. We are not wound about with red tape. Those who cry out about "red tape," in some instances at least, are themselves entangled in red tape. We are willing to give a municipality the benefit of the doubt. We do not even ask that any municipal project be brought to us in perfect engineering, legal and financial form before approving it. We have adopted a system of tentative allocations of funds. On my motion, the Special Board for Public Works, about a month ago, adopted a resolution as follows:

"Resolved, That upon a proper prima facie showing that a proposed State or municipal public works project is socially desirable, is satisfactory from an engineering point of view, and can be financed under the law, the Public Works Administration may make an allocation of the money required for such project on the condition that not later than thirty days after such allocation, the financial and engineering features of said project be worked out and a final contract, satisfactory to the Administrator of Public Works, be executed, failing which the tentative allocation shall be without effect."

Here is concrete evidence of our willingness to proceed without loss of time and with a minimum of technicality. Come to us with a prima facie case and we will set aside the money for you. Then you can proceed without delay to supply us with the necessary explicit engineering, legal and financial details. You have all of these in your files. At least you ought to have them. We are more liberal than any lender on a large scale since the beginning of the world ever thought of being, but we are not dropping taxpayers' money into the hat of a blind man. You ought to know whether the works you propose are desirable and possible from a social, legal, financial and engineering point of view. If you do know there is no good reason why you should not quickly take us into your confidence. If you don't know or can't demonstrate it and still demand that money be given you, good sportsmanship requires that you do not raise the cry of "red tape" against us. Bring us your projects supported by the facts that are undoubtedly within your knowledge and you will get prompt action.

This Public Works Program is a great cooperative movement. Under the swift and sure leadership of President Roosevelt, the Federal Government is cooperating with the States and with municipalities; States and municipalities are cooperating with each other. The success of the Public Works Program will depend upon our ability to work together for the common good. If we can all pull together in the general interest, forgetting personal or political differences, striving to accomplish the greatest good for the greatest number of our people, regardless of who they are, or where they live, we will definitely turn this tide of depression and come out of it with a renewed self-confidence, a mutual respect, and a spiritual acceleration that we have not felt since the war.

In order to recover a firm economic foothold, we must work surely, quickly and cooperatively. We must forget ourselves. We must organize ourselves into a rescue party for the whole of the United States. It is sadly true that many people are not hesitating to profit personally at this time. They are willing to let the other fellow be unselfish and patriotic. There are those who, cynically and selfishly, will not overlook any opportunity to feather their own nests regardless of the general distress. But this contemptible attitude on the part of a selfish few will not determine the final result any more than the fate of a decisive battle is determined by the ghouls who rob the dead bodies on the battlefield the night after the battle.

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Concrete Pavement Construction Over Swamp

In 1930 the Shawinigan Water & Power Co. of Montreal, Que., constructed 9.2 miles of single track concrete pavement between a point on the Canadian Northern R. R. and Rapid Blanc, a power dam site on the St. Maurice River. The pavement was 10 ft. wide and was used in the transportation of materials and supplies for the construction of the power dam. The slab was 8 in.-10 in. thickness reinforced with end corner bars at the rate of 86 lb. per 100 sq. ft. and with bar met reinforcement to the amount of 56 lb. per 100 sq. ft.

At one point on the job was a stretch of swamp. In order to guard against damage from excessive settlement at this point the company's forces had placed a double layer of corduroy timber under 4 ft. of gravel fill over the swamp for a distance of approximately 400 ft. To protect the permanent slabs against excessive displacement in the event of settlement it was decided to install additional reinforcing steel as dowel bars through the transverse joints over the corduroyed section. The dowel bars ⅝ in. round by 30 in. long, spaced 18 in. apart, were fitted with pipe sleeves on one side of the transverse joints. The maximum settlement occurring at this point was found subsequently to be 22 in., but there was no indication of slab displacement or cracking at any point over the fill. There was, however, a noticeable increase in the width of the two transverse joints at either end of the fill. The pavement between apparently behaved as a flexible unit.

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DEPUTY ADMINISTRATOR OF CONSTRUCTION CODES APPOINTED.—Malcolm Pirnie, Consulting Engineer, New York City, has been appointed Deputy Administrator of Construction Codes by the National Recovery Administration.

Comparative Visibility of Highway Signs

INVESTIGATIONS of the comparitive visibility of standard luminous and nonluminous highway signs have been made recently by the U. S. Bureau of Public Roads in cooperation with the National Bureau of Standards. The scope of the investigation covered three principal phases: First, personal observations of standard signs having different color combinations as between background and legend, letters of various standard sizes without reflector buttons being used for this purpose; Second, night observations of signs equipped with reflector buttons; and third, daylight observations made on the same signs to determine what effect there is, if any, on legibility, thus furnishing a basis for comparing their legibility with that of the signs not equipped with reflector buttons. The tests extended over a period that included summer as well as winter climatic conditions and offered an opportunity to view the signs in bright sunlight, during rains, snow and fog, and against the changing natural background.

Conclusions Summarized.—The report of the investigations occupies 20 pages of the September issue of Public Roads, the official publication of the U. S. Bureau of Public Roads. The conclusions arrived at from the investigations are summarized as follows, the various phases being treated in the order in which the tests were made.

Daylight Observations on Nonluminous Signs.—The first phase involved determination of the relative values of the ground colors and the legibility of the respective legend colors and design. All evidence deduced and analyzed points to the definite conclusion that the standard yellow background with black design color, under all conditions which might reasonably be expected to obtain on either a city street or upon a rural highway, is much superior to black on white or white on black. Not only has this been demonstrated to be true as to readability of the legend but the yellow background is more arresting to the average observer, is more conspicuous by contrast with the average natural or artificial background, and, therefore, has a greater signal value than the other backgrounds or combinations. Moreover, by adopting a definite shade and hue, such as is covered by the specifications of the American Association of State Highway Officials in rule 53 of the sectional committee on colors for traffic signals of the American Standards Association, it may be possible by legislative act or otherwise to prohibit the use of this distinctive shade for advertising or for purposes other than official road signs upon the highways controlled by state or other properly constituted authorities. Obviously it would be difficult to obtain restrictive legislation for black or white backgrounds.

Night Observations on Nonluminous Signs.—The investigation of the effect of headlights or local illumination such as street lights upon the signs not equipped with reflecting units was not in any way conclusive. When some of these observations were made the ground was covered with snow, of which there were several piles immediately adjacent to the line of sight, and conceivably this condition will obtain for several months in the year over a large area of the country. Such conditions emphasize the inadequacy of the daylight signs at night.

With respect to the use of reflecting units, there are two points to be considered which in a degree appear to conflict. In urban areas there is usually a great deal of illumination from street lights, electric signs, and other sources falling on the sign; and local regulations may require that headlights be dimmed or depressed. These conditions do not, as a rule, obtain on rural highways. In city driving speeds are relatively slower and clear perception of the sign message is more readily had than on rural highways. In view of these considerations, the conclusion is forced that the colorless button with a diameter of 0.76 in. with a minimum spacing of 1 in., center to center, is the most efficient. This is notwithstanding the large increase in the efficiency of the 0.58-in. diameter button with dim headlights over the same button with full headlights. For rural use the small button apparently has a superior long-range signal value but is less readable than the unit of larger diameter.

Daylight Observations on Luminous Signs.—The effect on distinctness in daylight of inserting reflecting buttons in the letters has been gone into exhaustively. As indicated by the tests, the effect of such insertions, even though approximately 50 per cent of the superficial area of the letter is taken up by the use of colorless units, is not serious at 200 ft. and the difference between black and white letters is negligible.

Recognition by Shape of Sign.—The recognition by the road user of the existence of a potential hazard by the shape or outline of the sign plaque alone has been briefly touched upon and the idea is susceptible of further development. Particularly is this true in view of the trend toward the use of symbols. The use of symbols, except for the arrows indicating curve or direction, is not considered as effective as outlining the sign with buttons. At night the road user can best be warned at long ranges against such hazards as may exist at narrow bridges, highway intersections, and other places in this category by clearly defining the shape of the plaque with reflecting units. Having been so warned he will be able to read the character of the hazard at 200 ft. or well within braking distance for a car traveling at the maximum authorized speed.

These investigations had to do exclusively with the reactions of the average road user to the sign messages as measured by the tachistoscope. No account has been taken of the technical details of construction of the reflecting units, composition, refraction coefficients, or other optical properties of the glass; every effort on the other hand, was made to simulate actual driving conditions. Maximum personal response to the warning is the ultimate consideration in sign design and it is not believed that optical analysis or other technical tests, however exhaustive, can measure this response. In the foregoing tests, 121 individuals were used as observers and these made a total of 7,710 separate observations involving about 12,000 items. These observers represent a fair cross section of the potential car-driving public. A number of them, however, had not received driving permits and were not car drivers. The gamut of education and personal intelligence was wide. A number of observers were furnished through the cooperation of the American Automobile Association, which in turn enlisted the aid of the local employment bureau. As indicated in the text, both males and females were used. Observations were made under the varied weather and seasonal conditions obtaining in the District of Columbia, and the results of the investigation may be taken as representative of the comparative visibility of the signs throughout the country as a whole.

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65 PER CENT OF RURAL TRAFFIC IN INDIANA ON STATE ROADS—The total mileage of state and county roads in Indiana is 77,245 miles, of which 8,423 miles are in the state highway system. The percentage of state roads, therefore, is approximately 10.9.

Stabilization of Low Cost Roads by Calcium Chloride

By C. A. Hogentogler, Jr.*

LOW cost road surfaces of gravel, top soil, sand-clay and similar types consist of granular particles to furnish structural strength and hardness, silt filler to prevent the granular particles from rocking, and clay particles minute enough to cause the connecting water films to have high cohesion.

Absence of water films causes dust and ravelling due

A Clay Road. High Cohesive Properties But Unstable in Wet Weather

to dryness; too much moisture results in failure due to rutting. The more rapidly moisture evaporates from road surfaces, the dryer they become; and the dryer they become, the wetter ensuing rains will make them. This is because extreme dryness causes the formation of small cracks and fissures in the clay binder which provides means for rain water to enter and soften the interior of the road surface. In damp surfaces, consisting of proper constituents, fissures do not form, therefore, water is shed from the surface of the slab which, consequently, remains stable. Therefore, any admixture which assists in preventing the road surface from becoming extremely dry serves at the same time to stabilize it by preventing it, also, from becoming wet.

At the same time, the ability of the admixture to perform its stabilizing service depends largely upon the character and the proportions of both coarse and fine material comprising the low cost surface. Therefore, stabilizing of such surfaces consists of two steps; proper grading based upon character of granular fraction and binder, and incorporation of proper kind and amount of moisture stabilizing chemical. This is made apparent by a brief review of the fundamental aspects of both stable and unstable materials.

Stability Defined—Stability is merely the resistance of the road surface to rutting. It depends upon the resistance of the granular particles to sliding over each other and the stickiness or cohesiveness of the binder. Hogentogler and Aaron have called the former the "sand-paper," and the latter, the "fly-paper" effect. See "Important Developments with Respect to Subgrade Investigations" Proc. Ninth Annual Meeting, Highway Research Board, 1929. The greater the force compressing the granular particles, the greater is their resistance to sliding. Other things being equal, the heavier the granular particles, the greater is this compressive force.

Asphalts and tars furnish the cohesion in bituminous surfaces; clay, silt, and moisture, in top soil, sand-clay and similar types; and moisture films alone, in the beaches stabilized temporarily by the passing tide.

Cohesion furnished by colloidal clays and bituminous materials is well understood as compared with that furnished by moisture films.

Weight and Roughness of Grain Important in Cohesionless Materials—Oats, dry sand, and quicksand are quite unstable as compared with lead shot and damp sand. Thus, the unfortunate individual who steps into a bin of oats or bed of quicksand, only sinks deeper with every attempt to extricate himself. Likewise, perfectly

A Gravel Road. High Frictional Properties But Unstable in Dry Weather

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dry beach sand displaces underfoot and mires the wheels of automobiles as readily as soft plastic clay.

Damp sand, in contrast, supports not only one's own weight without displacement, but also that of heavy structures, and, in addition, resists the abrasive action of racing automobiles. Fine lead shot is far more stable under any type of load than dry sand of the same particle diameter.

Differences in weight and surface texture of particles explains these differences in stability. For instance, the oat grains are comparatively light and have very smooth surfaces offering but little resistance to sliding. Consequently, a load quickly displaces and sinks through them. The dry sand grains are more stable for two reasons: first, the individual grains are heavier, and second, their surfaces are rougher.

Their greater weight causes the sand particles to have more intimate contact that the oat grains. This, alone, increases the resistance of the sand to displacement.

A Stabilized Gravel Road. Cohesive and Frictional Properties Balanced in Soil Composition for All-Weather Stability

Greater roughness of particle adds still more to the higher stability of the sand. Difference in particle weight alone could explain the higher stability of the lead shot as compared with that of the dry sand.

The relative absolute weights of the oats, sand and lead are respectively about 50, 165 and 700 per cubic foot. The relative stability of these materials would be in the same ratio as these weights if grain size, shape, and roughness and loading conditions were equal. See "Load, Road and Subgrade" by Hogentogler and Terzaghi, *Public Roads,* May, 1929.

Quicksand a Condition, Not a Material—Completely immersed sand is less stable than thoroughly dry sand also because of reduction in particle weight. Immersing the sand reduces its particle weight by 62 lb. per cu. ft.

A stream of water flowing upward through the sand, as from a spring, in addition to simply immersing, reduces the effective weight still further. This, combined with increased separation of the grains by the velocity of the water upward, produces quicksand.

The high stability of the damp sand is due to the cohesion of the tiny water films cementing the grains together and thus preventing their sliding over each other. This cementing value increases as the thickness of the films decreases. For instance, in completely immersed sand the moisture film cohesion is practically equal to zero due to saturation of the pores. As drainage and evaporation decrease the moisture content of the sand, the moisture films become smaller and their cementing effects correspondingly greater, and, acting like a taut rubber skin gradually drawing tighter, increases the pressure of the sand grains against each other until a maximum resistance to movement is reached. Further reduction of the moisture content gradually eliminates the moisture film cohesion, until finally, only the cohesionless dry sand remains.

Moisture Films Capable of Producing Monstrous Cohesion—Generally, water may exist in soils in three different forms; gravitational, capillary and solidified. Gravitational water occupies the larger soil pores. It is controlled by the force of gravity; can be removed by drainage; freezes at 0° C.; and boils at 100° C.

Capillary moisture exists in the smaller capillaries; it has higher surface tension than normal water; is not controlled by the force of gravity; can be removed by evaporation but not by drainage; and does not freeze even at temperatures considerably below normal freezing temperatures.

Solidified water is that remaining on the surface of the very small colloids after drying to constant weight. It causes dried cohesive soils to exist as cakes instead of powder; has monstrously high cohesion; does not freeze, and cannot be removed by evaporation.

Laboratory experiments and well known natural phenomena disclose the monstrous forces moisture films are capable of producing. For instance, mechanical forces well up in the thousands of pounds per square inch are required to consolidate fine grained clays an amount equal to the shrinkage produced by the consolidating cohesion of the moisture films during the drying of samples in the laboratory.

Likewise, sap or moisture furnished by the roots in the ground, rises to the tops of trees 300 to 400 ft. in height. The hydrostatic pressure required at the base to sustain a column of water of such height equals as much as 170 lb. per sq. in. which is equivalent to the steam pressure sufficient to propel a locomotive. When the moisture films become so small as to have only the thickness of the walls of a soap bubble, about 1/476,000 in., the stabilizing force equals about 800 lb. per sq. in.

Also, Keen has shown that laboratory samples of sand grains with a binder of clay colloids can be 19 times as resistant to compression as the same sand grains with a similar proportion of portland cement binder. See "The Physical Properties of Soil," Longman, Green & Co.

Finally, the practical possibilities of moisture films for increasing the stability of road surfaces is emphasized by the racing course at Daytona Beach, Florida, which accommodates the speeds requiring the highest stability and abrasive resistance, and yet consists only of perfectly cohesionless fine grained particles cemented together temporarily by interstitial sea water film.

Dampness of Surface Essential—Low cost road surfaces of the types mentioned in the first paragraph of this article must be maintained in a damp or slightly moist condition in order to benefit by the stabilizing moisture film cohesion. Unfortunately, mechanical applications of water alone cannot accomplish this purpose Highway research, however, has pointed out the scientific, but withal, the inexpensive method of solving the problem. It consists of treating the surface with deliquescent, or water retentive, chemicals.

The researches of Fred Burggraf reported in "Proceedings of the Twelfth Annual Meeting of the Highway Research Board"; of W. R. Collings and L. C. Stewart, reported in Bulletin No. 36 of the American Road Builders Association; and of H. F. Clemmer, reported in the current Engineering press, clearly demonstrate that calcium chloride is admirably adapted to furnish the desired hygroscopic or deliquescent properties. This inexpensive chemical, which is easily applied, is capable of absorbing moisture from the air, when necessary, in addition to retaining the proper amount of that furnished by precipitation.

WHY IS CEMENT Sold F. O. B. Destination?

By HALBERT P. GILLETTE

ANY pricing system suitable for marketing cement is dependent upon the fact that cement is highly standardized. It is listed as Standard No. 1 by the American Standards Association. Practically all portland cement meets this standard. As a result there is little or no practical difference in the quality of different brands. As a further result no informed buyer (as nearly every buyer of cement is) will pay a premium for any one brand over any other brand. Sellers offering their product at a higher price than offered by some other seller in the same market at the same time must lower such higher prices to the lowest price offered in order to be competitive. When higher offers (by insistence of the buyer) are thus reduced they become equal to the lowest and therefore equal to each other—that is, they become uniform. This tendency to uniformity of price is a natural economic law applicable to any uniform product such as cane sugar, No. 1 wheat or portland cement. This tendency toward uniformity under free and open competition is recognized by the United States Supreme Court in a decision favorable to the cement industry dated June 1, 1925. It is similarly recognized by noted economists in this and other countries. The standardization of the product, the resulting tendency toward uniform prices in any given market at any given time, the fact that there are now 96 manufacturers operating 173 mills in 34 states, and the fact that cement in general is bought by fully informed professional buyers have a bearing on any pricing method that may be used in the buying and selling of cement.

Different people at different times have suggested different methods which might be used for marketing cement. All of these may be classified under four heads as follows:

I. A single f. o. b. mill price for all buyers regardless of their location;

II. Different f. o. b. mill prices at the same mill for shipment to different territories;

III. Equalization method—that is, a single f. o. b. mill price with stipulation that upon receipt of receipted freight bill, resulting destination price will be lowered to equal the destination price of any other seller;

IV. Delivered price—that is, an f. o.b. destination price.

To get a clear picture of these four methods and of their advantages and disadvantages to buyers and sellers, they are briefly described in the following paragraphs:

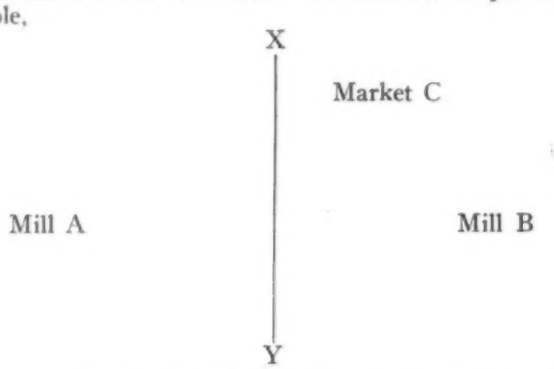
I. A SINGLE F. O. B. MILL PRICE FOR ALL BUYERS REGARDLESS OF WHERE THEY ARE LOCATED. This method was tried out in the early days of the cement industry. At that time cement from Lehigh Valley mills, with that imported, supplied practically the country's entire demand. As there were few mills elsewhere the method worked fairly well. With the construction of more plants in different parts of the country and the consequent growth of competition, the situation changed. Frequently a dozen or more competing companies located at different points, and with varying freight rates to destination, solicited business in the same market. With an f. o. b. mill price, the customer paid the freight and generally bought from the nearest company in order to secure the lowest freight rate. Unless its price were abnormally high the mill nearest such market or group of markets enjoyed a virtual monopoly of the business in those markets. Not being competitive in those markets, other mills had no contacts with buyers and buyers were in position to do business with only one seller. This tended to destroy competition and to keep prices higher than when more sellers were in position actively and regularly to solicit business. With the building of more mills in different parts of the country and the consequent growth of competition, experience disclosed the imperfections of this method and it was gradually abandoned.

II. DIFFERENT F. O. B. MILL PRICES AT THE SAME MILL FOR DIFFERENT TERRITORIES. With the further increase in number of plants, competition continued to develop and the practice of quoting different f. o. b. mill prices for deliveries to different destinations came into use by some mills. If a manufacturer wished to secure business in territory farther from his mill and nearer the mill of a competitor, he quoted a lower price f. o. b. his mill than he did for territory closer to his plant. This helped to offset the lower freight rate from his competitor's mill. If he wished to sell in markets yet more distant, he would quote a still lower mill price. But since the title to cement sold f. o. b. mill passes at once to the buyer, this method allowed him to make what disposition of it he desired. As a result many buyers, in order to get low mill prices, purchased from mills relatively far away and then diverted such shipments to territories close to the supplying mill. Thus distributors were able to manipulate cement shipments without risk to themselves. This method also was disadvantageous to cement users because it exposed them to possible loss or damage that might occur during transit and to inconvenience and expense in attempting to secure adjustments. These disadvantages of the plan to both manufacturer and buyer, outweighed its virtues and it, too, was gradually abandoned.

III. EQUALIZATION METHOD, that is single f. o. b. mill price to all buyers regardless of their location, with stipulation that any differences in the total price would be equalized with the total price offered by any other mill on presentation by the buyer of receipted freight bill. While this plan prevents the evil of diverted shipments (mentioned in preceding paragraph), it possesses certain other features which make it undesirable to both buyer and manufacturer. The price results produced by the equalization method are essentially like those that obtain under the method of pricing f. o. b. destination (described and designated hereinafter as Method IV). Any criticisms that might be made of the one would apply equally to the other. The net prices to buyers in a given market at a given time tend to be uniform in either case. Under the f. o. b. destination price plan, however, uniformity

results from the simple, easily understood plan of quoting f. o. b. destination. Under the equalization plan, uniformity would be secured by the cumbersome and laborious process of figuring in each case the differences in various mill prices as well as the differences in freight. This would entail almost endless work and bother on the part of both buyer and seller and might easily cause confusion and misunderstandings in the relations between the two. It also would make the buyer liable for possible loss or damage during transit as he takes title to the cement at the mill rather than at destination.

All of the foregoing methods, Nos. I, II and III, are variations of selling f.o.b. mill. Accordingly, these may now be further discussed as a single group by the following illustration and simple diagram. A and B are cement mills. The line XY is the line of equal freight rates between the two mills. To take the simplest example,



suppose each mill should maintain a price of, say, $1.50 f. o. b. mill. Obviously, then, customers on the left side of the neutral freight line would buy from Mill A and those on the right side from Mill B. Since no informed buyer of a standardized product like cement will pay a premium for one brand over another, neither mill would sell a barrel of cement to be shipped beyond the neutral freight line, XY, so long as it adhered rigidly to its single f.o.b. mill price. This would give each mill a monopoly within its own district. There would be no competition. If each mill had an annual capacity of a million barrels a year and if each territory consumed a million barrels annually, then the two mills could run full, each supplying its own territory.

But suppose that mill A's territory suffers in some year from a drought or other set-back and a consequent radical reduction in construction while B's territory remains prosperous. Would mill A be content to cease or greatly reduce operations because of little or no demand in its territory while mill B would run to capacity in serving its prosperous territory just across the line of equal freight rates? Would not mill A much prefer to take less than $1.50 at its mill on some quantity of cement to be shipped beyond the XY line rather than greatly to curtail production while mill B prospers? And if Mill A did shrink its mill price in order to share in the business in territory B, it no longer would have a rigid mill price. And in thus shrinking its mill price to be competitive with Mill B in territory B, it would, in effect, be competing with Mill B, not on an f. o. b. mill basis but on an f. o. b. destination (delivered price) basis. The foregoing case is relatively simple because only two mills are considered. If, as is the case under present conditions, more mills are injected into the picture, there would be no fundamental difference in the result except that the more active competition would make the shrinking of mill prices a daily rather than an occasional necessity.

Or consider another simple illustration: In the territory of Mill A lives a contractor who has had friendly business relations with Mill A over a period of years. The contractor's preference for doing business with Mill A is well known. He is awarded a job at C, some distance across the line in territory B. He asks Mill A to quote on cement for his new job. If Mill A adheres to a rigid mill price, it quotes $1.50 f.o.b. mill and the contractor, after he has had someone, probably the railroad people, figure freight rates for him, learns that he will have to add, say, 60 cents to the mill price of $1.50, making his cost $2.10 at destination C. However, he investigates further and learns that he can buy cement from Mill B for $1.50 f.o.b. Mill B and, pay say, only 40 cents freight to C, making his total cost in that case $1.90 at C. Under this plan the contractor would be forced for economy's sake to deal with another than his regular source of supply and Mill A would then lose a good customer, at least to the extent of the cement required on the job in question. But one may ask whether Mill A would be willing to sacrifice this business (and other business of the same and other buyers on the same basis), or whether Mill A would prefer to shrink its mill price of $1.50 to $1.30 so as to retain both the business and its standing with the contractor by making a price of $1.30 f.o.b. mill plus 60 cents freight, or a total of $1.90 at C as made available by Mill B for shipment to destination C. The latter, of course, or equivalent variations thereof, is what resulted when f.o.b. mill prices were used over thirty years ago. It would result today if f.o.b. mill prices were in effect. And, as in the preceding example, there would be no fundamental difference in the result if more and more buyers were injected into the picture. In short, neither in this case nor in the one described in the preceding paragraph, nor in any variations of either, can a cement mill adhere to a rigid f.o.b. mill price without sacrificing business that it could otherwise obtain.

All of this may be summarized by saying that when competition and other economic factors force a mill to shrink its mill price, the result, in effect, is the same as quoting a destination price (except for the disadvantage to buyers and sellers hereinbefore cited in the descriptions of mill price methods I, II and III). To say it another way, active competition soon forces all f.o.b. mill price methods (Nos. I, II and III) to become the same in their ultimate effect as a delivered price (f.o.b. destination) method. This leads, then, into a discussion of the latter (designated hereinafter as method No. IV).

IV. DELIVERED PRICE METHOD—THAT IS AN F.O.B. DESTINATION PRICE. This benefits both buyer and seller. The benefits to buyers may be summarized as follows:

(a) It relieves them of trouble, expense and possible misunderstanding that might result from the equalization plan;

(b) It assures buyers of prices from any seller as low as the lowest that any other seller offers (as described in a later paragraph);

(c) It relieves buyers of the burden of figuring different freight rates on different quantities from different mills. The manufacturer with experienced traffic men in his organization assumes this obligation, keeps in touch with Interstate Commerce Commission rulings regarding rates, converts rates per hundredweight to rates per barrel and relieves the buyer of these responsibilities and burdens;

(d) The f.o.b. destination method satisfies the immediate needs of the buyer. He is not interested in what cement costs him at the mill, but in what it costs him at the place of use both because this is a more direct

means of comparing laid-down costs of cement from different mills variously located freightwise and also because his competitors, whether dealers or consumers, are almost always local—that is, those who resell or use the cement at the same place he is using or reselling it;

(e) With the growth of the industry, the increase in competition and the increase in number of buyers, this method gradually came into general use and for more than thirty years has given general satisfaction to buyers.

In addition to the foregoing benefits to buyers, the method of selling f.o.b. destination also is more equitable to manufacturers. For example, it enables them to compete actively in any market they choose by the simple process of learning the market price and meeting it if they desire to share in the business (as shown by Fig. 1). In addition it enables a manufacturer to help dealers maintain their distribution in their natural markets by preventing others from diverting cement from a higher price market to a lower price market as would be possible if cement were sold by a manufacturer at different f.o.b. mill prices (as described under II).

Because this method of selling cement f.o.b. destination contains more advantages and fewer objectionable features for all parties concerned than any of the three other possible methods, it gradually began to come into general use over thirty years ago.

As the destination price in any given market is established by the mill willing to take the lowest delivered price, any manufacturer wishing to do business in that market must meet that delivered price. This results in the buyer getting the lowest price at which any seller is willing to sell, and of being able to get it from any producer serving that market. While this necessarily results in uniformity of *delivered* prices, yet each manufacturer nets a difference price depending on the distance his mill is from the market. When delivered prices are uniform, those manufacturers nearest the market secure the largest net prices for their cement; those farthest away secure the smallest net prices.

This is easily illustrated by the following example. Suppose there are four cement mills—A, B, C, and D.—seeking business in a market called M. This market has a 50-cent freight rate from Mill A, 60 cents from Mill B, 70 cents from Mill C and 80 cents from Mill D. This gives A a 10 cent advantage over B, a 20 cent advantage over C and a 30 cent advantage over D. A figures he can sell cement at M for $2.00 with 50c freight; this nets him $1.50. Then, if B, C and D want to do business at M they must meet A's delivered price at M. This results in B netting 10c less than A, C netting 20c less and D netting 30c less. Unless B, C and D can make the sacrifices required by the market at M as made by A's delivered price of $2.00, then A will monopolize the market at M. This illustrates that uniform destination prices for cement are the result of active competition existing at manufacturers' mills, with the producers netting varying prices for their product based on their distance from the markets in which they sell.

The same economic law of varying net returns holds true in the case of other standardized products. Number one wheat is a simple example. Growers may live in Minnesota, the Dakotas or some other states. They may ship their wheat to Minneapolis, Chicago or to some other market. It doesn't matter how far they are from the market or how much it costs them to raise the wheat. They will all receive the same uniform price that prevails at any given time in any given market to which they ship. But their net returns will vary, like the net prices of a cement maker, with the differences in freight from farm to market. The same result is experienced by a grower of specified grades of live stock. He may live in Iowa and ship to Omaha, Kansas City, Chicago or St. Paul. His stock will sell for the same that other like grade of stock are sold for at the same time in the same market. His net returns, however, will vary as the freight charges from different farms to market vary. Similarly and for the same reason cement producers receive smaller net prices for shipments to certain markets and larger net prices for shipments to other markets.

From the foregoing it is clear that there are two fundamental reasons why the practice of selling f.o.b. destination gradually came into use in the cement industry over thirty years ago:

(a) Competition forced some such method or an approximation to it:

(b) The method offers more advantages and fewer disadvantages to both buyers and sellers than any other method and hence is preferred by both buyers and sellers.

(a) The f.o.b. destination plan or its equivalent is inevitable under the free competition that exists today. The only alternative to it is monopoly. This would be the result in each mill's territory if each adheres rigidly to a single f.o.b. mill price plan for all shipments such as existed in the early days when mills were few and competition negligible. Growth of competition gradually forced the abandonment of a single f.o.b. mill price system because it created monopoly and limited the seller's business to territory near his own mill. It prohibited him from seeking business or serving customers in any other territory and it limited the number of sellers with whom a buyer could deal. As has been shown, the only other two possible f.o.b. mill price methods (different mill prices for different territories and the equalization plan) are forced under competition to approximate the same results as obtain under the f.o.b. destination method. They may be called mill prices but in effect they are perverted destination prices. They possess any weaknesses that may characterize the f.o.b. destination plan and in addition lack some of the advantages to buyer and seller which inhere in that plan. The f.o.b. destination plan therefore is inevitable either in the simple easily understood form in which it exists today or in a substitute, inferior and complicated form under another name.

(b) The present f.o.b. destination plan is generally followed also because of its demonstrated advantages to the buyer of trouble, expense and misunderstandings reasons it is followed. It may possess some defects as does almost any plan used by human beings in a widespread industry. But experience has shown that it has fewer objectionable features and more desirable ones than any other possible plan. It enables the manufacturer to compete actively and to serve customers in any market he chooses. It permits dealers to buy from any number of sellers serving any given market. It relieves the buyer of trouble, expense and misunderstandings possible under the equalization plan; saves him the work of figuring complicated freight rates; satisfies his immediate needs by enabling him readily to compare his

net delivered costs with those of his competitors, and most important of all, it assures the buyer that the price of any seller in his market will be as low as the lowest that any other seller offers.

Because some form of f.o.b. destination plan is inevitable and because it offers to all concerned more advantages and fewer disadvantages than any other possible plan, it gradually has become the plan followed in the cement industry.

General View of New Bridge Over Hudson River Between Troy and Menands, N. Y.

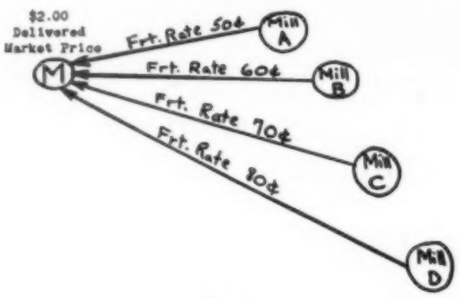


Fig. 1

Mill	Mill price (Net price rec'd at mill)	Feight rate from mill to market M	Delivered price at market M (Mill price plus freight)
A.....	$1.50	$0.50	$2.00
B.....	1.40	.60	2.00
C.....	1.30	.70	2.00
D.....	1.20	.80	2.00

Buyers of cement are interested in the price to them at the place of use, such as market M. The delivered price in market M equals the mill price plus the freight rate from mill to market. Since informed buyers will not pay a premium for one brand over another (of a standardized product like cement), any mill desiring to sell in market M must offer its product delivered at M at a price no higher than the lowest. This results, under active competition, in uniform delivered prices at M but in varying net prices received at the different mills A, B, C and D depending upon their distance freightwise from the market M as shown by the diagram and table above. If instead of the foregoing, the mill prices at A, B, C and D were equal, then the delivered prices at market M, on account of varying freight rates, would be different. Since no informed buyers would pay a premium to B, C or D, all the business would go to A; it would have a monopoly in market M; there would be no competition. On the other hand, when delivered prices of a standardized product in any given market are uniform, there is active competition. It is not apparent at the market but this is simply because, as shown by the diagram and table, the competition has shifted from the market to the mills.

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Troy-Menands Bridge Has 341 Ft. Movable Span

Another new bridge across the Hudson River, between Troy and Menands, N. Y., was formally opened to traffic on July 17, 1933. The span is similar in almost every detail to that of the bridge which now crosses the Hudson at Albany, N. Y., and which was opened last winter. Both bridges are of the vertical lift type with movable spans 341 ft. long, weighing 2,700 tons each. As far as is known, these spans are the heaviest of their kind in the world. The span on the Troy-Menands bridge will be raised and lowered by two General Electric 250 hp., 410 r.p.m. shunt-wound motors.

Control for the bridge is located in a switch house mounted above the center of the movable span, where the operator has an unobstructed view of both bridge and river. As a safety precaution, the entire system is interlocked so that the span can not be raised until the gates at both ends are in position and the traffic signals for motorists have automatically turned red. When the span reached the top of the towers, a distance of 77 ft. from the bridge level, a signal to proceed is flashed to boats on the river. The electrical equipment for the bridge was designed and built by the General Electric Company.

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Cotton Fiber Pads for Curing Concrete

Tests of cotton for curing newly laid concrete roads have been completed recently by the Bureau of Public Roads. The tests of the Bureau of Public Roads consisted of preparing concrete slabs and covering them with cotton mats, and burlap. One slab was left uncovered.

The mats, which were submitted by the Texas State Highway Department, consisted of plies of raw cotton separated by loosely woven cotton cloth. Mats of from 1 ply to 9 plies and from ⅓ in. to 3 ins. in thickness were used.

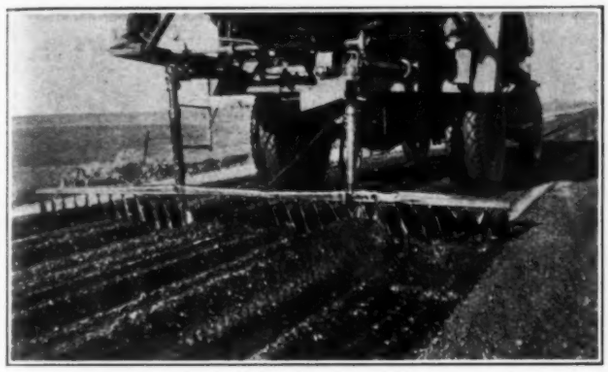
All of the cotton mats appeared to be effective curing agents and gave better results than burlap. With a one-ply cotton mat the rise in temperature from early morning to the hottest part of the day was only 60 percent of that under burlap and about one-third of that of unprotected concrete.

Black Top Construction In Western Nebraska

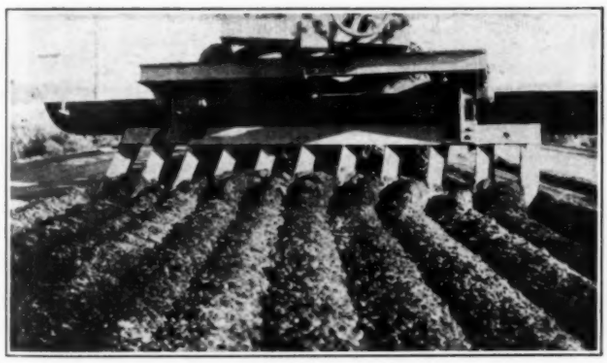
SOME interesting work on the low cost form of "mixed in place" road is now under construction on the Lincoln Highway. The section between Ogallala and Brule, Neb., and from Big Springs to a point five miles west of the latter place was contracted last year both for grading and finish. However, on account of delays in grade preparation the black top work was only started in June this year.

The bituminous mat surface will finish 1¼ in. thick and the average width is 24 ft. The method of manipulation is of special interest as it introduces some new features both in specification and equipment used.

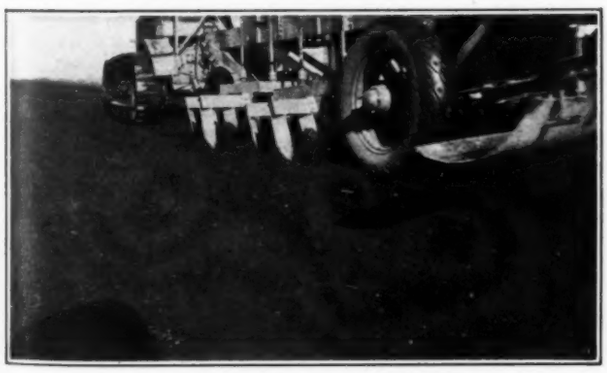
The material used is brought from two sources, viz: screened gravel from which all oversize, above 1 in., is removed; and secondly, fines in a certain proportion from a local sand pit. These aggregates are dry mixed to get proportions right, then spread in center of road about 10 ft. wide to dry prior to receiving the first shot of oil.



Oil Distributor Making First of Three Shots



Turbo Mixer in Action



Turbo Mixer Making Final Round

Mixed by Turbo and Ready for Blade to Spread

Blade Spreading Finished Mix

The Finished Road

The mixing is done on the grade center before it is primed. The two shoulders then receive their priming and when ready the mixed material is spread full width from side to side by blading till a level mat is formed.

One of the new ideas back of this method is that the shoulders are primed where greatest wear resistance is required—on the same principle that concrete roads are now reinforced on edges instead of the middle of the slab.

The new feature in equipment used is the Turbo mixer and drier (made by the Parsons Co., Newton, Ia.). This machine possesses a special action which first of all dry mixes the proportioned aggregate; secondly it aerates the material in a wide spread (8 to 10 ft.), and thirdly it starts mixing right behind the distributor and carries this part of the process through in a rapid and satisfactory manner.

The only other machine used for the manipulation was a caterpillar auto patrol grader for moving over the mixed material during the Turbo mixing and later for spreading it.

The accompanying illustrations from photos taken on the job illustrate how the process was carried out.

The contractors, Inland Construction Company, Omaha, have the following personnel directly interested in the work: General Superintendent, Mr. H. Dehl; Superintendent on Job, Mr. Geo. Taylor; Timekeeper, Mr. M. P. Laughlin. The State Highway Department at Lincoln is represented on the job by Mr. Middleswartz, District Engineer and Mr. Boyner, Project Engineer.

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New Finishing and Joint Installing Methods on Indiana Road

New finishing and joint installing methods were employed by Hinton & Smalley, Celina, O., on their job at Portland, Ind. The contract was on U. S. Highway 27 and covered 30,000 ft. of road. New ideas put in practice on this job were to rescreed the concrete after the free water has disappeared and while the concrete was still in good workable or plastic condition, and by so doing, refill all settlements in the concrete surface caused by minute water pockets—to be releveled to an exact surface; also to place all the joints in front of the screed, instead of in rear.

The type of joint used was the dummy poured joint. Steel V-plate was inserted by the combination joint and screeding machine, ½ in. wide and 2½ in. deep. Before the concrete had taken its initial set, this V-plate was removed and the corners were edged with a special edging tool so that the joint when poured with asphalt filler was 1 in. wide, the idea being to use it as a traffic marker and thus eliminate painting.

At certain points transverse contraction joints of the same character as the longitudinal were installed by the same machine, but contrary to usual methods, the transverse installer was located in front of the machine and was operated by engine power. Following the installation of the transverse joints, the longitudinal joints were placed in position from the center of the machine, and following on the rear of the machine was the screeding unit.

Experiments have been made by the Flexible Road Joint Machine Co., screeding over expansion joints at the correct time or just before the initial set of the concrete, and it was found that excellent riding surfaces were secured by this method. This practice was first initiated some years ago by H. G. Sours, Engineer of Summit County Highway Department, Akron, O., and the results were so satisfactory that other counties in the state adopted the same practice. Roads built by this method as early as six years ago have such smooth surfaces and free from bumps that it is a delight to travel over them.

The experiments in Indiana, while somewhat similar, were executed by different means and methods inasmuch as two finishing machines were used, the rear machine continually moving forwardly and thus did not have to move in reverse, and the final screeding was done after the free water had drained from the concrete. This is considered important inasmuch as there was virtually no latenance and, consequently, it is expected that there will be no peeling of the surface in years to come as has happened in the past on jobs where the final screeding was done at a time when the surface contained free water.

The Flexible Road Joint Machine Co. of Warren, O., furnished the equipment for this demonstration. The Highway Department has been so well pleased that they have adopted this method as an alternate in the specifications.

Flex-Plane No. 2 Combination Jointing and Resurfacing Machine at Work on Indiana U. S. Highway Route No. 27. Note Screed on Rear of Machine for Final Screeding that Installed Contraction Joint

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ENGINEERING FIRM OF VAN WAGONER-BUCHANAN REORGANIZED.—Reorganization of the engineering firm of Van Wagoner-Buchanan, Inc., with headquarters at Pontiac, Mich., has been announced as a result of the withdrawal from the firm of Murray D. Van Wagoner, State Highway Commissioner. The firm is a corporation through which Van Wagoner and Bruce Buchanan of Pontiac were engaged in the private practice of engineering for several years. This firm has been engaged in both private and public works, and because of the recent assumption of public works responsibilities by Mr. Van Wagoner, due to his appointment by President Roosevelt to the Michigan Advisory Board, under the Public Recovery Act, he felt it incumbent upon himself to withdraw from any connection with private engineering practice. The new organization which will continue in business will be known as Bruce Buchanan, Inc., of Pontiac, and will continue to operate in the engineering field in both public and private enterprises.

The Cause of Heat and Electron Emission From Suns and Planets

By Halbert P. Gillette

IT CAN be shown that in spheres of homologous density, if the gravitative pressure between the particles of each sphere causes radiation, then the constant emission of radiant energy varies as $r\ m,^2$ in which r is the radius of the sphere and m is its mass. The heat emitted by the sun and the earth is roughly in accord with this formula, and becomes very nearly in accord if the sun's molten core diameter is two-thirds of that of its visible disk. Sir James Jeans has calculated that the sun and every other star must have a molten core. If so, that core may be surrounded by luminescent gas to a great depth. Hence it is not unlikely that the sun's molten core has a diameter two-thirds that of the sun's luminous disk.

Upon this hypothesis the temperature of the sun's luminous disk should decrease gradually from the center of the sun to two-thirds of the radius from the center, and should then decrease very rapidly out to the periphery. This is exactly what occurs, as determined by spectroscopic observations. The temperature curve just mentioned is a straight line from the center out to two-thirds of the radius, and for the remaining one-third it is a parabola.

The sun's specific gravity is 1.41 if its diameter is that of its visible disk, but if it has a molten core of two-thirds of that diameter, then that core must contain nearly the entire mass of the sun, and its density must be about 4.75. The density of Venus is 4.86; that of the earth is 5.52; and that of Mars is 3.96. The average of these three is 4.78, or almost exactly that of the sun's molten core as above determined. The mass of Mercury is only very roughly known. The densities of the four outer-most large planets are: Jupiter, 1.34; Saturn, 0.71; Uranus, 1.27; Neptune, 1.58. But these densities are admittedly not the densities of their solid or molten cores, for they are based on diameters equal to those of the visible disks which are known to be gaseous. The average apparent density of Jupiter, Uranus and Saturn is 1.4 or almost exactly that of the sun. Hence if their molten or solid cores have diameters that are two-thirds those of their visible disks, those cores have densities that average almost the same as the average density of the planets Venus, Earth and Mars, as well as the density of the sun's core, namely 4.75. Saturn then remains the only apparent exception, but it is noteworthy that its apparent density is almost exactly half the apparent density of the sun. If Saturn has a solid or molten core whose diameter is half that of its disk, the density of that core must be $8 \times 0.71 = 5.66$ or approximately that of the earth.

Since the earth is known to be encased with several electron-shells, we are justified in inferring that the same is true of the other planets and the sun. If those shells are somewhat denser than those of the earth, they may collect sufficient matter to become visible disks much larger than the cores. The formula at the beginning of this article leads to the conclusion that in stars like the sun and in very massive planets, the electron-shells would be very dense as a result of the great radiation of energy under gravitative pressure. Radiation of energy, as Einstein has proved, means conversion of mass into energy. Hence both protons and electrons are constantly being converted into radiant energy in the sun and planets, but more protons must be converted if pressure is the cause of conversion; for protons are far denser than electrons and therefore, on the average, are deeper down where the pressure is greater. The "death" of a proton releases an electron from the surface of a planet or star, and thus electron-shells are generated and maintained.

The simple hypothesis of the slow conversion of mass into energy under gravitative pressure serves to explain the constant emission of heat from stars and planets and makes clear the phenomenon of constant emission of electrons from the earth.

According to this hypothesis, gravitative pressure causes radiation of a type that is convertible into light and heat. Since gravitative force exists whether masses are in contact or not, it follows that it causes radiation in masses that are in motion relative to one another. It is but a step from this conclusion to one that is somewhat startling at first, namely that all molar motion results from asymmetrical or unbalanced emission of radiant energy. Prior to Einstein this would have seemed incredible. It is not only credible but, I think, probable.

A second step in the evolution of this hypothesis leads to the conclusion that the asymmetrical radiation that causes gravitation is itself the result of radiations from the gravitating masses. This would cause greater pressures upon their "front faces" than upon their "rear faces," and thus tend to increase the escape of radiant energy from their "rear faces" and produce the so-called "pull" of gravitation.

If gravitative pressure is competent to cause the emission of radiation by the "destruction" of mass, other pressures must have similar effects. All atoms are organized aggregates of hydrogen atoms. Aston has shown that in the process of aggregation mass is lost. So here we have evidence of the conversion of mass into radiant energy that occurred when each atom evolved from hydrogen. I infer that the constant disintegration of uranium, radium, etc., is a phenomenon analogous to the constant disintegration of the stars and planets, the main difference being that the mutual attraction of hydrogen atoms in the complex atoms, produces an enormous pressure that converts positons into radiant energy and releases electrons.

When atoms unite to form molecules heat is emitted, and this, too, probably results from the closer packing of the hydrogen constituents. Thirty years ago I was able to show that many an atom has its own "heat of formation" when it unites chemically with another atom, each contributing its quota; and that the strength of the union increases as the "heat of formation" increases. No one then dreamed that the "heat of formation" of molecules had its counterpart in the heat of formation of each atom from the hydrogen "bricks." Nor was it dreamed that the sun shines because part of its mass is constantly being converted into radiant energy. Thanks to Einstein we are now able to calculate that the sun is losing by radiation 4,200,000 tons of heat, which is equiv-

alent to mass, every second. Even at this enormous rate the sun loses only 1/15,000 of its mass in a billion years.

Since the moon generates a very great amount of heat, according to the formula above given, its core may long remain molten, and it may maintain rotating electron-shells millions of years after its surface crust has ceased to rotate relative to the earth.

Jeffreys has assumed that the heat emitted from the earth's interior is mainly caused by radiation from uranium or the like. That hypothesis has but little to support it, but it was plausible.

If increase of pressure increases the rate of disintegration of matter, the converse may be true, and decrease of pressure may lead to integration or evolution of matter from radiant energy. Recently the Joliots apparently effected an integration of matter from radiant energy by projecting alpha particles (helium) against lithium. "From each collision they recovered a baron atom and a neutron which together weighed more than the original lithium atom and the alpha particle." There have been other recent laboratory experiments that also point quite conclusively toward gain in mass at the expense of energy, which is the converse of mass disintegration.

It is probable that disintegration and integration of molar mass are constantly occurring. Also it seems likely that the photons of radiant energy are essentially the same as the electrons of molar mass. Probably the photon itself is composed of still smaller units of mass.

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Early Street Paving

A recent issue of the Boston *Transcript* contains the following interesting article from its London correspondent on early street pavements in England:

The paving of streets may surely be earlier than some would lead us to think, for among the early records of the little town of Tonbridge is the following, dated 1317: "Edward the Second empowers his trusty men of Tombridge, know ye that at the request of our well beloved and faithful Hugh de Audley Jr. We have granted to you in aid of enclosing and paving the said town, that from the day of making these presents, until the end of three years next ensuing, you may take in the said town of saleable things coming to the same, the tolls underwritten, grain, cattle, hides, fresh meat, salmon (fresh or salt), sheep, goats, squirrels, linen, canvas, cloth of Ireland, worsted, wine, honey," and many other things. It is inconceivable that the great cities, especially London, should not have had well-paved streets long before this time.

An early allusion to street paving will be found in Fitzstephen's account of Becket's journey through France in 1159: "When he entered any town or village, his iron-bound chariots came creaking over the stones of the streets." It was in the second half of the thirteenth century that paving became general in English towns, as is tested by the Patent Rolls of the period. Patents for "pavage" (that is, authority to levy tolls on goods traffic to defray the cost of paving) were granted by Henry III to Beverly and Grimsby in 1255, and to Shrewsbury in 1268. His successor, Edward I, issued a large number of patents of this sort, Chester, Lincoln, Worcester, Northampton, Boston, Rochester, Lichfield, Leicester, Appleby, Cambridge, Derby, Canterbury, Stafford, Warwick, Coventry and Bury St. Edmunds being among the towns concerned. These patents were valid for specified periods—two, three, five, or even seven years—and if the work were not completed they were renewed.

In 1284 an extension of a pavage patent was granted to the mayor of London, Henry le Waleys, "in aid of the paving of the city towards Westminster." Southwark received pavage patents in 1315 and at later dates. The road from Temple Bar to Westminster Palace was the subject of a commission in 1314 and patents for the work were issued soon afterwards. The 1315 patent—"to view and make good the defects of the pavement"—suggests that the street had already been paved. The commissioners were authorized to "distrain upon all those who had tenements or rents between the bar and the palace to pave before their respective tenements." In 1353 the Strand and King-street route was again the subject of a pavage patent.

The form of pavement seems to have consisted of small stones of irregular shape, cemented together, somewhat after the style of the paving that skirts the old houses at Chiddingstone, in Kent.

Pavage patents were issued also for the repair of main highways, in cases where the maintenance was not specifically an obligation of the manors or of certain responsible persons. Such patents were issued for the roads around London in the fourteenth and fifteenth centuries, the tolls on traffic to meet the cost being levied at various points. In these patents and the methods of repairing the roads we have the origin of the Turnpike Acts of later date. Auditors—sometimes the local clergy—were appointed to audit the accounts, and not infrequently we find that the accounts did not balance.

No real attempt was made to renovate our city of London or other towns in Great Britain until about 1302, which was about the date that the Worshipful Company of Paviors made a small beginning, when the city fathers gave instructions to drive out the pigs from the city, and appointed paviors to remove the filth from the fronts of the houses and pave the same in certain places.

Paving stones were used, but the same were collected from the bed of the river and the smaller tributaries, which ran into the Thames, sorted and laid on sand also collected from the rivers. These were the first attempts to "pave" and this system grew with the improvements in the selection of stone, and were later shaped, until the time came for the use of the "granite sett," as was used mainly from 1800 up to the coming of the mechanical carriage in 1900, and is in some cases still used.

It was Mr. George Burt of Swanage, Dorset, under his uncle, John Mowlem, who together worked under the Macadam system of roads from 1816 and it was George Burt who introduced the deep "Aberdeen Granite Sett" nine inches deep to London. The idea being that the depth like an anvil would if bedded on river sand (the original road material), stand up to the then modern horsed vehicles with iron tires and would not sink or move. This was found to be good and was the practice for many years in the city of London.

Roads in Great Britain were not roads, but mere tracks, even in London as late as 1736. The earliest law on the subject of the safety of our "ways" was in 1281. It directed that all trees and shrubs on either side of the horse tracks between market towns should be cut down for a distance of 200 yards to prevent highwaymen and robbers from taking people unawares on the road or track.

The first toll for the repairs of roads was made in the year 1346 on the authority of King Edward III. These now form part of London.

It was not until 1555 that an act was passed requiring each parish to appoint two surveyors of highways to keep them in repair by compulsory labor. At a later date the "Statute Labor Tax" was introduced.

The Traffic-Actuated Control System As Adopted in Montreal

By Robert B. Dodds, Jr.

Traffic Engineer, Automatic Signal Corporation, New York, N. Y.

THE first installation of a traffic-actuated control system, the invention of a professor at Yale University, was made in New Haven, Conn., on April 10, 1928. The system is based on the principle of actuating traffic signals by means of the traffic itself, and has seen its entire development during the past five years.

This system has been installed recently at approximately 50 of the most important intersections in the city of Montreal, Que.

This system consists of three major parts—the traffic signals, the traffic detectors and the control mechanism. The traffic detectors are placed in all approaches to each signalized intersection to record approaching traffic. The control mechanism receives the information from the detectors and assigns the right of way, by means of standard traffic signals, to the different streets in accordance with the traffic flow as indicated by the detectors.

The Signals.—The signals are mounted on a one-piece drawn steel post with an enlarged section at the base with a door to provide facilities for pulling in and connecting the wiring; the top portion is reduced in diameter to receive the standard signal head and also provides a space for mounting traffic signs, such as "No Left Turn," etc. This type of post has been adopted as it requires a minimum sidewalk space and provides maximum strength owing to its one-piece heavy steel post construction.

The signal bodies are of cast aluminum and are fitted with silvered glass reflectors and standard roundel lenses; the reflectors and lenses are each carried in a cast aluminum carrier hinged to the signal body to facilitate wiring and re-lamping.

All of the signals are of the standard three-color type with red, amber and green lenses, and have been wired to give the following color sequence:

Street A.	Green	Amber	Red	Red	Green
Street B.	Red	Red	Green	Amber	Red

This is called the "split-amber" color sequence. The amber light is shown as a clearance interval only to the street losing the right of way and not to the street receiving the right of way. This sequence has the advantage of preventing the dangerous practice of motorists who insist on starting on the amber light before green and, hence, makes for greater safety. The flexibility and design of the system is such that any desired standard color sequence can be obtained, but it is believed that the above sequence is the most satisfactory.

At all intersections the signals are located on the far right-hand corner of each approach. At intersections in the downtown area, and at other locations where there is a substantial volume of pedestrian traffic, there are two signal faces mounted on each of the signal posts. This arrangement ensures that pedestrians have a signal in their line of vision, regardless of the direction in which they are moving.

At intersections where there is no appreciable movement of pedestrians and extra signal faces are not required, only one signal face is mounted on each post. This gives motorists approaching the intersection a signal indication on the far right-hand corner of each approach.

Power Supply.—Power is supplied at each intersection to the control unit. The control units is mounted on one of the signal posts and a cast aluminum box is provided for the reception of the power company's meter and the main switch; power is supplied at 110 volts, 60 cycles. The direct current required for charging the condensers, and the low voltage current for detector relays are provided by means of transformers and a rectifier included in the controller itself.

The Traffic Detectors.—The traffic detector is a pressure-sensitive contact-making device connected to a relay in the control mechanism and is actuated by the pressure of a wheel passing over it at any point. One or more detectors are installed in each approach to the intersections in the normal path of movement of vehicles. The detectors are placed in the pavement and

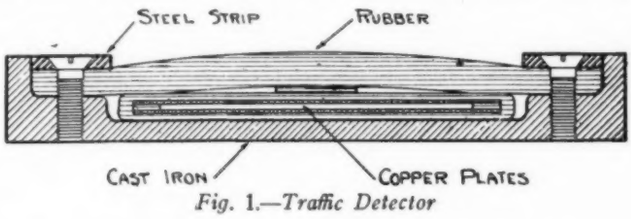

Fig. 1.—Traffic Detector

their surface is flush with the road surface (Fig. 1). They are located in each approach a distance of from 75 to 150 ft. back from the stop line, depending on the stopping distance required for the normal speed of traffic on the particular approach.

At certain intersections where tramcars use the intersection on one or more approaches, special detectors are used for the tramcars. The tramcar detector operates as follows: A section of the trolley wire, 6 in. in length, is covered by a sleeve insulated from the trolley wire by heavy insulation. The sleeve is electrically connected to the trolley wire by means of a piece of nichrome wire. When the trolley wheel passes over the insulated section, the current is drawn through the nichrome wire and a small relay is operated by the voltage drop in the nichrome wire. When the relay is closed it in turn operates a relay in the control mechanism in exactly the same manner as the standard traffic detector described above.

The Control Mechanism.—The control mechanism is the most important part of the robot system. Its function is to receive the impulses from the detectors and then assign the right of way, by means of the signals, in accordance with the traffic demand from instant to instant, as indicated by the detectors. Many more problems are involved in the design of a control which accurately registers, remembers, and responds to actual traffic demands that vary widely from minute to minute. than in the fixed time control which repeats a fixed control cycle, irrespective of the presence or absence of traffic.

With the robot control system the traffic cycle is divided into an initial "go" interval, a vehicle "go" in-

terval, an "amber" or cautionary interval and a "red" or "stop" period.

The initial interval is a pre-determined time period which commences at the start of the green signal and allows time for vehicles to get into motion. After this interval the length of the green signal is controlled by the vehicle interval, which is also a pre-determined time period, equal to the time required to drive a vehicle from the detector to the center of the intersection. This interval is lengthened on the "green" period each time a vehicle passes over the detector.

The "amber" period is a pre-determined time interval following the display of the "green" signal. There is also a maximum traffic interval which is also pre-determined. This is the maximum time which traffic may be required to wait for the "green" signal after passing over a detector.

All of these intervals are separately adjustable for each thoroughfare.

Principle of Interval Timing.—The timing of the various intervals is based on the principle that a definite period of time is required to charge a condenser to a definite difference in potential through a fixed value of resistance. The elementary timing circuit used in this equipment is shown diagrammatically in Fig. 2. The initiating switch, a contact on the cam of the control, is closed to start the time interval. The condenser, having previously been drained of residual charge, begins to charge at a rate inversely proportional to the total amount of resistance in series with it.

The tubes shunted across the condenser through the terminating relay is a flasher tube of special design, which will conduct no current until the voltage across its terminals reaches the ionizing point. The tube, upon ionizing, instantly reduces its internal drop to a value considerably less than the flash-over value, and maintains this reduced drop until it is extinguished. When the voltage across the condenser reaches a critical value for the flasher tube, it flashes over and the difference in potential between the condenser and tube-drop is developed across the terminating relay. This produces an inductive resistive current impulse in the relay, which lasts until the surplus energy in the condenser is exhausted and the tube extinguishes.

The contact on the terminating relay in the delayed impulse circuit is so arranged that it connects 110 volts a.c. to a solenoid (not shown in circuit) which thus becomes energized for a short time when the condenser discharges through the terminating relay. The solenoid by a ratchet mechanism notches the cam shaft around one notch. The cam in the new position closes the proper cam contact or initiating switch for the next time interval.

The control provides for a total of eight time intervals each independently adjustable over a suitable range. The fundamental timing circuit for all of the intervals is the same as that in Fig. 2 described above, but some special features are applicable only to certain of the intervals. For example, the time extension feature, one of the most important in the traffic-actuated control, applies only to the two vehicle intervals. Time extension is defined as the progressive extension of the green signal interval by successive vehicles crossing the detector approaching the green signal.

Time extension is accomplished as shown in Fig. 2 by short circuiting the condenser through a suitable low resistance by means of a contact on the vehicle detector relay which is operated by each car crossing the detector when the signal is green. Thus each time the detector relay is operated by a car crossing it, the condenser is short circuited and discharged, and the vehicle interval

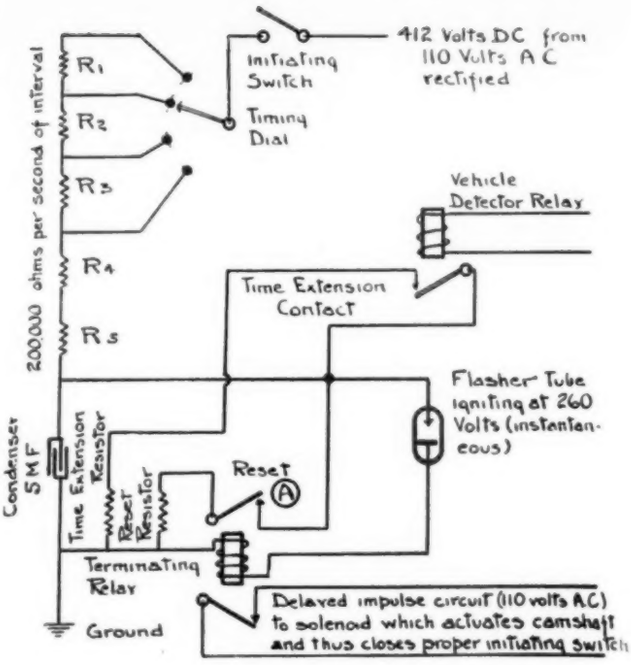
412 Volts DC from 110 Volts A C rectified
Initiating Switch
Timing Dial
R1
R2
R3
R4
R5
200,000 ohms per second of interval
Vehicle Detector Relay
Time Extension Contact
Flasher Tube igniting at 260 Volts (instantaneous)
Condenser 5 M F
Time Extension Resistor
Reset Resistor
Reset
A
Terminating Relay
Ground
Delayed impulse circuit (110 volts A.C) to solenoid which actuates camshaft and thus closes proper initiating switch
A For completing discharge of condenser at the end of each time interval - Really operated mechanically by solenoid.

Fig. 2.—Diagram of Connection of Timing Mechanism

is reset. The green signal time is thereby extended by the length of the vehicle interval from the instant of actuation of each car crossing the detector.

Actually, the method of draining or resetting the condenser is not quite that shown in the diagram, for in practice the terminating relay itself does not have a reset contact. Such a contact is shown in the diagram in order to avoid the complication of showing all the mechanical operations resulting from the working of the terminating relay. The circuit shown in the figure for shunting the condenser through the reset resistor is really controlled by the solenoid on the delayed impulse circuit. This solenoid not only works the initiating switch as already described, but is also connected mechanically to a rocker arm which closes a contact in the reset circuit and thus drains the residual charge in the condenser so that each time interval is started with the condenser completely discharged.

The length of the impulses which the detector relay receives is approximately inversely proportional to the speed of the car crossing the detector. Therefore, since the rate of discharge of the condenser is inversely proportional to the resistance in the discharge circuit, it is obvious that by choice of a suitable resistance in series with the detector relay contact (in the discharge circuit) the length of the vehicle interval time extension can be made to vary automatically with the speed of the car, and thus increase the efficiency of operation.

The resistor in series with the time extension contact is usually 2,000 ohms. If, however, it is desired to incorporate in the control system the special feature of time extension in proportion to car speed, this resistance is increased to about 20,000 ohms. In this case a car going approximately 15 miles an hour will completely discharge the condenser and thus extend the time a full vehicle interval, whereas a car going more than 15 miles an hour would not complete the discharge of the condenser and would only extend the time a fraction of a vehicle interval proportionately to the speed. For ex-

ample, a car moving 30 miles an hour would extend the time approximately one-half of the vehicle interval.

The timing mechanism operates on a step-by-step principle, rather than by cylic timing. This is accomplished by using a cam shaft with a 6-position cycle, one position for the "amber" light and two for the "green" (one for the initial and one for the vehicle interval), on each street. The cams operate a system of contacts and set up the proper electrical connections for each position. As already explained the cam-shaft is notched over by an a.c. solenoid and ratchet system, which in turn is operated by the terminating relay of the proper interval-timer at the end of each interval. When the cam takes a new position, it lights the proper traffic signal lights and closes the initiating switch of the proper interval timer. Each time the solenoid operates, it closes the discharge contacts of all timing condensers, thus draining them for a fresh start on the next interval. This insures against errors in timing due to a residual charge in the condenser. Each of eight time-intervals operated by the dials on the front of the control panel is individually adjustable and completely independent of others.

This control equipment is wholly enclosed in a dust-tight aluminum casing with a glass window for viewing all contacts and moving parts. A dial panel mounted below provides means for adjusting all time intervals from the outside. The whole control unit is mounted inside a weatherproof housing for protection against the elements and unauthorized persons tampering with it. The door of the housing is also fitted with a door giving access to a small compartment which contains switches for turning the signals on and off and for the manual control of the intersection by a traffic officer if desired at any time.

The cost of operation of the system is low, the average energy consumption of the control equipment, exclusive of lamps, being about fifteen watts per intersection.

Features of Operation.—The control is arranged so that the right of way remains continuously on the street which used it last until called by traffic approaching on the other street. Switches are provided, however, which can be set, if desired, so that the right of way will return automatically to rest on any selected street in the absence of traffic.

Cars approaching a "red" light on any street are given the right of way immediately unless traffic on the other street is using the intersection.

If the intersection is actually being used by traffic on the opposing street, the waiting cars are given right of way to proceed at first break in the opposing traffic.

If no break occurs naturally in the opposing traffic, this traffic is automatically stopped at the end of a reasonable maximum period and the waiting cars are given the right of way.

When continuous traffic on either street is stopped by the operation of the maximum period to allow waiting traffic on the other street to use the intersection, the right of way reverts at the first opportunity to the street on which the continuous traffic was interrupted.

The maximum period of either street is measured from the time at which the first waiting car arrived on the other street.

Each car approaching the intersection against a "red" light at a time when the opposing street is using the right of way is automatically recorded and remembered by the control so that the right of way will later be transferred to it without the necessity of recrossing the detector.

The time of the "green" period on each street is governed by the flow of traffic on that street, each vehicle approaching the intersection under such conditions affecting the control so as to extend the "green" period for its protection. The control, therefore, allows only such time as is actually needed on each street in accordance with the immediate traffic demands. The timing of the traffic periods is thus automatically adjusted by the traffic itself.

The control is arranged so that push buttons for pedestrians may be connected to it to permit the pedestrians to operate control in exactly same manner as vehicles.

In the downtown district of Montreal there are a number of narrow streets which are in some cases used for traffic in two directions. In these locations directional detectors are installed whereby cars traveling in one direction only will operate the control.

There are also several intersections at the top of fairly steep grades on which it was desired to give the tramways the right of way. At these locations pre-emptor equipment has been installed, so that, when the tramcar passes its detector, a special relay is closed in the control, which immediately switches on the "amber" period, if the cross street has the right of way at the time, so that by the time the tramcar reaches the intersection it has the "green" signal. This type of control has also been installed at one intersection where there are no tramway cars, to provide similar conditions for vehicles, as this particular thoroughfare is used by a large number of vehicles, a number of them being heavily laden trucks, that would find it extremely difficult to start on the grade.

Sample Typical Observations.—Below are recorded some sample typical observations of the length of the "green" interval allotted to each movement during consecutive cycles at different hours of the day.

INTERSECTION OF UNIVERSITY AND SHERBROOKE STREETS
APRIL 22, 1932

Length of Green Interval (seconds) Sherbrooke St.	University St.	Total Cycle
9:00 a. m. to 9:05 a. m.		
38	16	54
29	22	51
30	12	42
14	22	36
45	30	75
2:30 p. m. to 2:35 p. m.		
15	12	27
22	14	36
12	26	38
31	20	51
14	12	26
5:30 p. m. to 5:35 p. m.		
50	20	70
44	28	72
24	36	60
32	28	60
41	30	71

The above records, obtained at one of Montreal's heaviest traveled intersections, show the wide variation in the length of the "green" interval allotted to the two movements as determined by the actual traffic from cycle to cycle. This is of considerably greater importance than the variation in the total cycle, because the total cycle length might remain substantially constant and still permit the saving of a large amount of time, due to the wide fluctuation in the distribution of the "green" time between the two movements. Time saved in this manner is of great importance.

The system is operated continuously, since the objection to all night operation is removed by the elimination of unnecessary stops and delays and thus the safety element of continuous operation is retained.

Acknowledgment.—The foregoing is an abstract of a paper presented before the Engineering Institute of Canada.

EDITORIALS

"Queer Street for the Buses"

The Illinois Commerce Commission has ordered motor-buses to limit their speed to 25 miles an hour on country roads. This drastic restriction apparently has as its object the entire elimination of bus transportation over country roads. The only inference that we are able to draw is that railway companies have persuaded that commission to wipe out bus competition.

ROADS AND STREETS has opposed the control of bus and truck traffic by either state or federal commissions that control rail traffic. We have urged that the control of motor vehicle traffic be vested in state highway commissions. Railway commissions will never be as well informed as highway commissions in matters relating to highway transportation. Moreover, railway commissions are apt to listen to the pleas of railway companies that trucks and buses be burdened with restrictions that will either reduce their competition or eliminate it entirely. That we were justified in this contention is made evident by the wholly indefensible speed restrictions imposed by the Illinois Commerce Commission.

An editorial entitled "Queer Street for the Buses" appeared in The Chicago Tribune of September 29. We quote it in full:

"The Illinois commerce commission has issued an order, a wholly unexpected one so far as the public is concerned, stipulating that bus speed shall be limited to 10 miles in business districts, 15 miles in residential streets, and not more than 20 anywhere within city limits or 25 on country highways. The purpose of the order is at least not self-evident and is apparently not candid. Any reason which can be assumed in public interest becomes ridiculous when it is examined.

"Highway safety is not promoted, because if a bus were restricted to the required speed it would become even more of a highway nuisance and would compel every other driver to pass it. Each bus would be in effect a dead obstacle on the road, contributing to the delay, annoyance and insecurity of all other traffic.

"It is not the duty of the Illinois commerce commission to destroy bus transportation and make operation and public use of it impossible and yet that would be the probable consequence of the enforcement of such a rule. The order does not indicate in what interest it was issued, and certainly no public interest appears of itself. Competing lines of transportation might find the new rules profitable to them in that they drove all the passengers away from the bus lines. Representatives of the companies say that this would be the only effect. The rule is not one of regulation but of extinction, and its purposes need considerable explanation."

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Let Us Have Straw Votes on Diversion of Gasoline Taxes

THE diversions of gasoline taxes and automobile license fees to other than highway uses is the most serious problem that confronts those interested in highway construction and maintenance. Since it is a political problem, it must be solved by methods that are persuasive to politicians. Since no political argument is so persuasive as argument that takes the form of ballots, and since nearly every owner of a motor-vehicle is a voter, we suggest that members of automobile clubs be asked to express their opinions as to existing and proposed diversions of gasoline taxes and license fees.

Frist, the officers of automobile clubs should be persuaded to engage in an energetic protest against such diversions.

Second, straw ballots should be taken in those clubs to show the sentiment of the members as to such diversions.

It was the results of the straw vote on the 18th amendment, which The Literary Digest sponsored about 18 months ago, that first led both political parties to see that the 18th amendment was amazingly unpopular. That straw vote indicated that the voters in the 48 states averaged 7 "wet" to 3 "dry" voters. Within the last few months the citizens of 32 states have voted on repeal, and the ratio of "wet" to "dry" has exceeded 7 to 3, thus confirming the straw vote above mentioned. Moreover, the straw vote has proved to be a remarkably accurate forecast in each of the 32 states.

We mention this fact because it demonstrates the accuracy of straw votes that are carefully and impartially taken. The public has come to have confidence in such straw votes, and most politicians have equal confidence in their significance. Hence straw votes by members of automobile clubs will be regarded by politicians not merely as expressive of opinion, but as mandates to discontinue the diversion of gasoline taxes—provided that a majority of the automobile club members are against such diversion. We have no doubt what their verdict will be. What shall we do to get that verdict?

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24,000 *Scientific Periodicals*

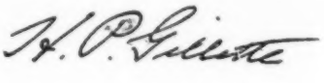
THERE is a British catalog entitled "World List of Scientific Periodicals" that contains the names and places of publication of more than 24,000 periodicals that may be classed as scientific or technical.

"Standard Rata and Data" is an American periodical much used by advertisers, because it gives current information as to all advertising media in America. It lists more than 1,600 "business papers." The term "business paper" has almost displaced the term "trade paper," although it is not satisfactory as a general name intended to include professional and scientific periodicals that carry advertisements.

Among the 24,000 scientific periodicals listed in the British catalog there are many that relate mainly to the business features of trades or industries and less to technical features. Even so, the number of those that are purely technical is amazing.

A generation ago most American teachers of science and technology believed that every student should be able to read French and German, in order to keep abreast with progress. We wonder how many of them still adhere to that belief. Our American periodical technical literature has grown to such proportions that few practitioners even glance through all that bears upon their specialty. Still fewer read any foreign literature.

We have reached a time when foreign technical literature must be reprinted in American periodicals if it is to be read by many American engineers. The buyers of books in foreign languages become fewer each year, not because those books lack merit but because money with which to buy and time in which to read them are lacking.



County and Township Roads

A Section Devoted to the Interests of Those Responsible for Secondary Road Improvement

The Low-Cost Rural Road System of Pennsylvania

By Samuel Eckels

Chief Engineer, Pennsylvania Department of Highways

PENNSYLVANIA'S Rural System composed of 20,000 miles of former township roads taken over under the Rural Highway Act, marks a step forward in the establishment of state highway systems, which is being eagerly watched by our sister commonwealths. To understand the various steps which led to the creation of a rural system it is necessary to consider briefly the manner in which state highway systems have been designated and additions made thereto.

Placing road in the state highway system is generally considered to be equivalent to putting it in line more or less definitely on an improvement program. Local residents are naturally very much interested in early improvement of their road. There is wonderful advantage in a surfaced road as compared with an unimproved road to rural residents who have to depend upon the highway for contact with physicians, schools, churches, cemeteries, neighbors and markets. The improved road is, in many cases, justified in its costs by the saving it accomplishes, to essential traffic, in operating costs.

The improved road, in addition to carrying essential traffic of communication and commerce, is such a factor in the social and educational life of a community that the apparent economics of existing traffic on a road may be dwarfed by the worth of a road as an aid to development. In many cases traffic has increased as much as 300 per cent within a short period following the improvement of a road.

Fundamentally, the functions of a state highway department are road improvements in degree commensurate with traffic importance, and adequate maintenance. It is a well established criterion for a state highway system that it include the principal inter-county roads and so long as principal inter-county roads remain unimproved the addition of mileage of lesser important roads to the system, without compensating increase of revenue, can only retard the proper development of the system.

But when the state highway system reaches or approaches completion of improvement, the question arises as to whether there should be adjustment by raising type of improvement, diverting road revenues to subdivisions of the state, diverting road funds to other purposes, reducing fees or other sources of road revenues, or increasing mileage of the state highway system.

Motor transport surveys and judicious cost accounting systems have enabled the highway engineer to deal with the problem of raising type of improvement as a simple problem of mathematics.

The question as to diversion of funds to subdivisions of the state becomes of increasing interest as the percentage of improvement on the state highway system increases. This may be by allotment of funds to the various subdivisions to be spent under local authority or by some form of state-aid or state-reward either of which is distribution of funds to be spent under complete or partial supervision of the department of highways on roads other than those of the state highway system, generally in conjunction with local contribution. The fact

One of the Higher Types of Construction Used on the Rural Road System of Pennsylvania

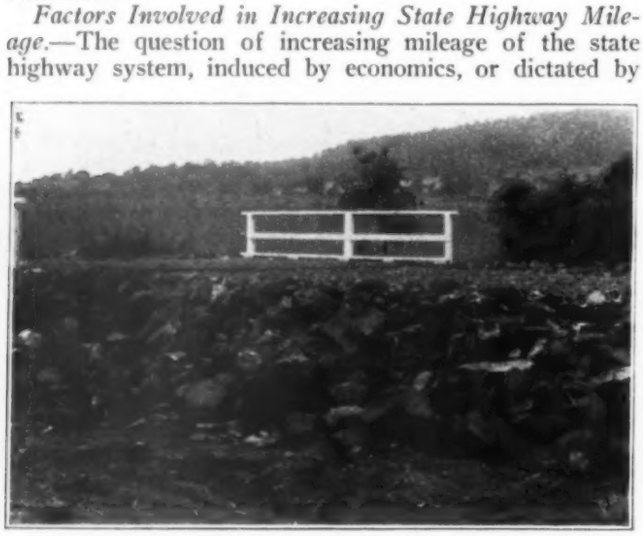
Preliminary Work on an Earth Road Improvement

that cities customarily receive no direct benefit from state highway construction and that some of the rural area is not directly benefited by state highway improvements has often been considered a strong argument for the return of some part of state highway revenues to the local subdivisions to be spent under local authority. More generally, however, the demand for equalization in the various states has been met by provision for some form of state-aid retaining to some degree state control over the expenditures of funds so distributed.

There is occasionally diversion of road funds to other purposes, but this practice is so generally recognized as unwise and inexpedient that it does not warrant lengthy consideration.

The question of reduction of fees or other sources of road revenues is to be approached as a question of economics, with due regard to the influence of popular demand. So long as road conditions are such that further developments will accomplish greater annual reduction in motor vehicle operating costs than the increase of road costs, and while road revenues are drawn directly from road users, the question of reduction of road revenues need not receive much consideration. The formerly upward mounting curve of motor vehicle registration has flattened, the average gasoline consumption per vehicle mile is decreasing, and normal future increase of revenue from licenses and from fuel tax may be small with constant rates.

Factors Involved in Increasing State Highway Mileage.—The question of increasing mileage of the state highway system, induced by economics, or dictated by broad principles and popular demand, involves a number of factors.



Stone Assembled Alongside Road for Use in Base Course

Assuming that the principal roads of the state are included and have been improved in the state highway system, principal interest is in the advantage of state administration as compared with county or township administration.

There are to be considered, first, the possibility of expediting road improvement; second, the probability of improved maintenance; and third, the generally accepted assurance of increased efficiency of administration.

Transferring of authority over roads from township or county to state is generally coincident with a popular willingness to incur additional costs for improvement and maintenance. Maintenance by the state brings advantages of extensive organization, more economic use of equipment and purchasing in large quantities. Administration by the state confers the benefit of federal-aid and other legislation.

These assertions are not derogatory to county or township officials. In some cases they may not apply, but in general they are applicable and are due to fundamental conditions.

The total mileage of public roads in Pennsylvania exclusive of city and borough streets is about 90,000, of which 77,000 miles were the obligation of township and county officials prior to the approval of the new road

Spreading and Sledging Base Course

program in 1931. Our counties with few exceptions have taken over and developed only a small mileage of local roads, approximately 2,000 miles for the entire state; hence the greater part of the mileage, 75,000 was the responsibility of the townships. Of this amount 73,000 miles were in the 1,514 second-class townships, each of which has three supervisors in charge of township roads.

Although the population of Pennsylvania averages 214.8 persons per square mile, many counties are sparsely settled.

While there has been a constant increase in the population of the state, the population trend in recent years in Pennsylvania, as well as in many other states, has been from rural regions to the cities, and in more than one-fourth of the counties there has been a decrease. In addition to the handicap of a small and decreasing population, several counties contain great areas of mountain and state forest lands which have very small or no taxable value.

Traffic on the principal state roads has been increasing to such a degree that certain sections of the highways

required widening to three and in some cases to four lanes. The increase has also affected minor roads, which formerly carried very few vehicles, in a smaller but important amount. Thousands of miles of township roads with little if any artificial improvement, developed into carriers of a greater volume of traffic than the main roads of 1911. The change of class of traffic from horse-drawn vehicles to motor vehicles with the resulting increase in weight and speed has overtaxed the capacity of the township roads.

Due to these conditions a large number of our townships were burdened with road tax levies of 15 to 20 mills and many had rates between 20 and 30 mills. In 1930 the entire road tax collected in the 1,514 second-class townships was $14,037,369.11 representing an average tax of 10.87 mills on a total valuation of $1,313,394,250.63. This tax provided an average of only $187.08 per mile for construction and maintenance of the township roads. Road improvements of particular moment, therefore, were restricted to the richer and minor number of townships. In hundreds of others the road funds were so small that the roads could barely be maintained in a passable condition. Thus, not only were the local regions where these conditions existed greatly handicapped for lack of road development, but

Crew Sledging Native Stone Base Course in Place

there was an unfavorable reaction by the general public which could not make free use of the roads.

I may say here, that as a direct result of taking 20,000 miles of township roads from the local authorities, the second-class township road tax levy in 1931 had been reduced to $13,021,647. In 1932 these levies had been reduced to $10,882,749, while in 1933 they were further reduced to $8,427,798. In other words, since 1931, owners of property have benefited by a total tax reduction of $6,792,747.00.

In 1933, 1,301 townships had reduced their tax levies as compared with 1931, while 168 townships made the same levies as in 1931, and only 9 townships showed increases.

The New Program—Initiation.—These facts indicated the desirability of placing the township roads on a more practical basis of development. Our highway engineers in 1927 began a coöperative study with the township supervisors with the view of designating a primary system of township roads. The layout of this system was largely completed in the summer of 1930.

Governor Pinchot advocated that the state assume a larger share of the tremendous tax burden carried by the townships in their road work and maintained that

Base Course of Natural Stone in Place

if the granting of state-aid and state-reward were discontinued, and work requirements on the state highway system were not increased, current revenues would be sufficient to take care of a large mileage of the most important township roads. The study conducted by the department of highways showed that about 20,000 miles would constitute the primary system of township highways. Governor Pinchot caused to be introduced in the Legislature a bill, known as Rural Road Act No. 203, to transfer these 20,000 miles to the State. City and borough streets were not included; thus the additional routes constituted in reality a rural road system. The bill had the most earnest consideration of all the members of the Legislature and was widely discussed throughout the State. As finally amended and corrected the changes in the bill amounted to less than one per-centum of the mileage originally proposed. The bill embodied more than 4,600 individual descriptions, citing terminal and control points. It was passed without a dissenting vote and was approved by the Governor on June 22, 1931.

Under the terms of the Act the described routes became the responsibility of the State on August 15, 1931.

The routes taken over include about 4,900 miles which had been improved in some manner by local authorities;

One of the Highways on the Pennsylvania Rural System

You Should About the Road

Laying ½ inch surface of Stanolind Cut Back Asphalt and aggregate on Michigan Boulevard during July, 1929. One half of the street was paved, then the other half, without stopping traffic.

Michigan Boulevard today, showing the good condition of the pavement. It is estimated that 61 million vehicles have traveled over this boulevard since the Stanolind Cut Back Asphalt surface was laid.

ASPHALTS FOR EVERY PURPOSE

Please mention ROADS AND STREETS—it helps.

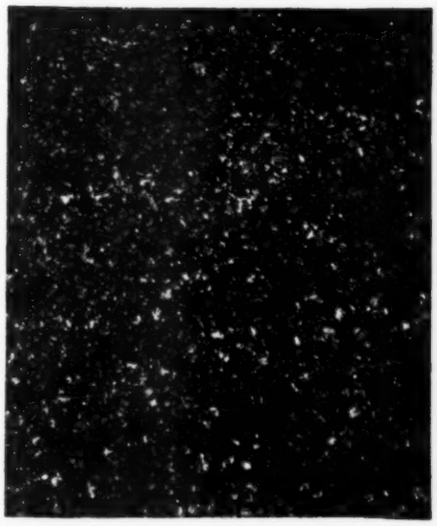
Know the Facts Material You Use

CUT Back Asphalt can be manufactured with many grades of materials but Stanolind Cut Back Asphalt is paving asphalt cement and diluent, the proper products for best results.

The paving asphalt is a pure high-grade cement which meets the standard accepted specifications. It has the highest cementing qualities.

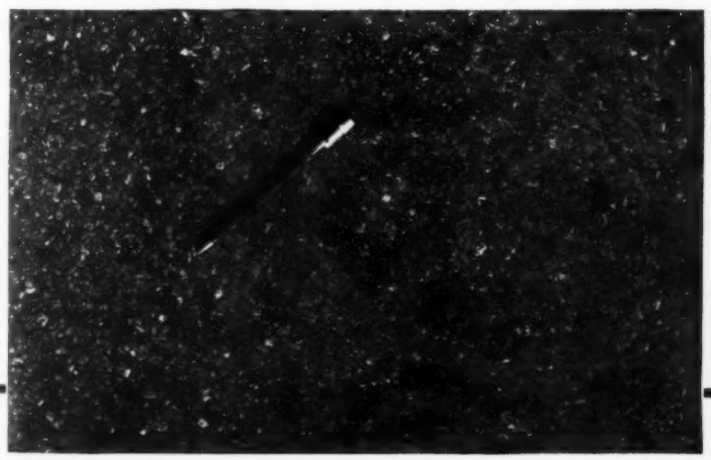
The diluent is not simply distillate oil, but a special product having the correct boiling point requirements to give the delayed initial set necessary for permitting mixing on the roadway and complete final set which allows the paving asphalt to return to its original consistency.

The half-inch surface of Stanolind Cut Back Asphalt and aggregate on Michigan Boulevard, Chicago, demonstrates the wearing ability of the Cut Back Asphalt Cement. For four years this thin surface has been handling the traffic on the world's most heavily traveled street.



Newly laid surface of Stanolind Cut Back Asphalt and aggregate on Michigan Boulevard, Chicago. This picture was taken just before this particular section was opened to traffic. Notice how thoroughly the asphalt has covered the stone. This is necessary for good binding.

STANDARD OIL COMPANY
(INDIANA)
910 South Michigan Avenue Chicago, Illinois
122-C



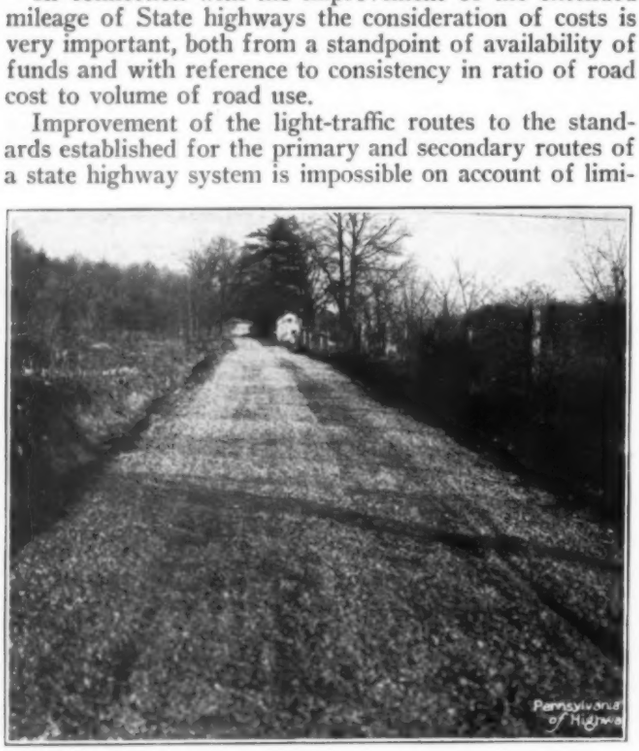
Stanolind Cut Back Asphalt surface on Michigan Boulevard today. Notice how the aggregate has bonded together by the cementing qualities of the asphalt.

NRA MEMBER U.S. WE DO OUR PART

but the majority of these improvements had been neglected as to maintenance and required immediate attention in the way of patching, edging, drainage, surface treatment and resurfacing.

In connection with the improvement of the extended mileage of State highways the consideration of costs is very important, both from a standpoint of availability of funds and with reference to consistency in ratio of road cost to volume of road use.

Improvement of the light-traffic routes to the standards established for the primary and secondary routes of a state highway system is impossible on account of limi-



Traffic Bound Road on Rural System

tation of funds. If such expenditures could be made they would show an unreasonable charge distribution for the volume of traffic benefited.

Although the purpose of Pennsylvania's new road program is to provide an all-weather surface to furnish all-year access to villages and farms, the relation of load limit to load capacity must receive careful attention.

In Pennsylvania the Vehicle Code permits a maximum gross weight of 26,000 pounds for four-wheeled motor vehicles, and 800 pounds on any wheel for each nominal inch of width of tire. It is impossible to build low-cost roads to carry such loads in all weather particularly when frost is coming out of the ground. Therefore, it may be necessary to restrict at times the load limit on low-cost roads and legislative enactment has given the Secretary of Highways authority to make such restrictions.

Reorganization.—To provide effective administration and supervision over the increased mileage of state roads, the field forces of the Department were reorganized. The eight former engineering districts were expanded to twelve districts with an engineer and staff assigned to each. A maintenance superintendent with necessary assistants was placed in immediate charge of the roads in each county, with the exception of Philadelphia County, which is coextensive with the city, and in one other case where a superintendent was given charge of roads in two counties.

Each superintendent has an office (in many cases state-owned), a repair shop, storage shed, and construction and maintenance equipment in accordance with the needs of the roads under his supervision.

Low-cost improvement of roads necessarily calls for low-cost engineering.

There is obviously greater difficulty in reducing engineering costs for contract construction than for work by department forces, but in either case there should be some reasonable relation between construction cost and engineering cost.

For the rural route improvements by department forces in Pennsylvania the preliminary survey consists of a chained and referenced center line.

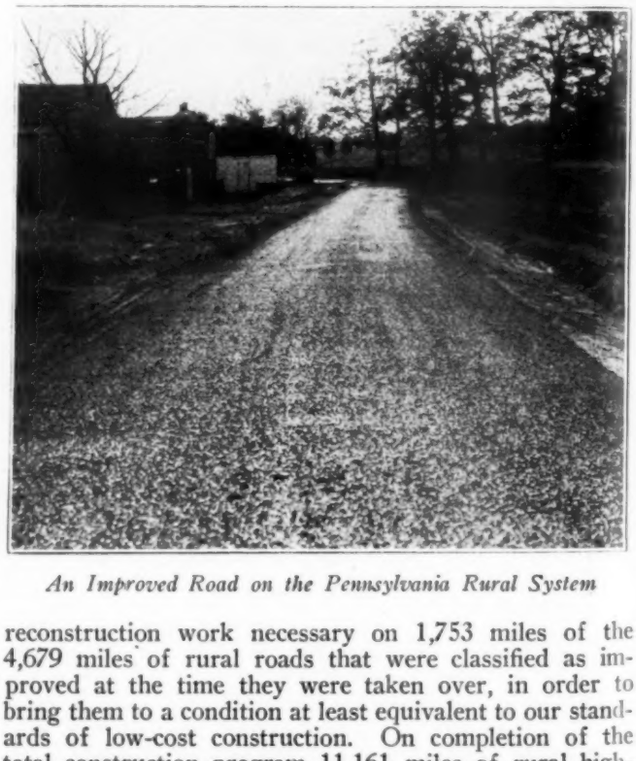
On department force work the foreman establishes lines, width and grades by eye or with string lines as the work progresses.

The work on the rural routes was authorized late in the season and was carried on by department forces, except that five projects were advertised for competitive proposals. Acceptable bids were received on three of these and work has progressed in a manner satisfactory to the department.

The requirement of rigid economy, however, in construction is paramount.

Under the stress of depression and critical unemployment, work on rural routes has been utilized for local relief. Only the nucleus of an experienced organization is placed upon these projects and local unemployment committees investigating the most needy cases, recommend to the men in charge those worthy of employment. Preference is given to married men with families, married men, and men with dependents. In practically every county the number of applicants has been greater than the number of available jobs and the work has been carried on in two or more shifts. Peak employment was attained during the week ending November 16, 1932, when 55,000 men were at work on our state highways.

On Aug. 15, 1933, two years after the rural system had been taken over by the state, the department had completed, underway, or authorized, 8,235 miles of construction on rural roads. This included reclamation and



An Improved Road on the Pennsylvania Rural System

reconstruction work necessary on 1,753 miles of the 4,679 miles of rural roads that were classified as improved at the time they were taken over, in order to bring them to a condition at least equivalent to our standards of low-cost construction. On completion of the total construction program 11,161 miles of rural highways will be adequately hard surfaced, leaving 8,995 miles still to be improved.

Progressive highway engineers have always recognized the necessity of conserving the taxpayers' moneys in construction of highways of adequate design to meet the requirements of existing and estimated future traffic.

The present economic trend is based on this premise together with the thought of constructing the most mileage with available funds.

It is a recognized fact that soil is the foundation for nearly all road surfacing and the amount of surfacing necessary on any road to carry traffic is essentially dependent upon the stability of the native soil in the road bed.

The following covers our practice up to the present time in rural road construction:

A. Earth Roads.—Earth roads are classified as unimproved and when taken over the following construction steps are necessary:

1. Proper drainage.
2. Shaping with drags or graders.
3. Widening, easing, and super-elevating curves.
4. Construction of shoulders, embankment, ditches and continued maintenance so that ditches are kept open together with removal of any excess material due to slides or sloughing of embankments.

One of the Higher Types of Surfaces on the Pennsylvania Rural Road System

5. Reducing grades which may require blasting or power-shovel work and removal of any sharp breaks in grade.
6. Stabilization by admixtures when present soil conditions are not deemed adequate for furnishing a substantial foundation.

B. Surface Course.—We have constructed a considerable mileage of base course having an average compacted depth of five (5) inches, with run-of-bank gravel, run-of-crusher slag or stone, local flint, or with "red dog" which is a by-product obtained from the incineration of soft coal culm banks.

Shale of the sand bearing nature, which does not readily disintegrate, is also being utilized for base construction. The clay shales, however, are not satisfactory for such work on account of their lack of durability.

We have utilized local materials wherever available subject to their having the necessary qualifications to furnish a durable and adequate base.

We do not stipulate any grading requirements for flint or "red dog" as they are naturally of smaller sizes. We, however, require that run-of-bank gravel, run-of-crusher slag or stone shall all pass a 4-inch circular opening with not more than fifteen percentum passing a 1¼-inch circular opening.

Native stone base course has also been constructed in which the aggregate consists of tough, durable stone, sledged or napped in place to insure solid bedding. The voids in the napped stone are filled by additional smaller fragments of stone from the same source or by the addition of fine gravel, crushed or granulated slag or cinders to obtain proper stability.

In some cases it is necessary to maintain such base courses under traffic until stability is obtained, and, if necessary, the material is surface treated with coal tar or water gas tar meeting our specification requirements for Class DL Specification 2, or Class DL Specification 3.

C. Traffic Bound.—These pavements are constructed of stone, slag, or crushed gravel. If gravel is used, we require that it shall contain at least forty percentum of crushed particles. Our grading requirements are such that all the aggregate shall pass a 1½-in. circular opening and contain from 5 to 25 percentum of finer particles passing ¼-in. circular openings, to obtain increased stability under rolling and traffic.

These traffic bound pavements are constructed of a compressed depth of from two to five inches, dependent on the subgrade conditions. They are subsequently treated with asphalt cut-backs, coal tar or water gas tar complying with department specification requirements for Class C Specification 1, Class D Specification 2 or 3, respectively, after proper consolidation or compression has been obtained, and are chipped with commercial ¾-in. stone, slag or crushed gravel, the gravel containing at least ninety percentum of crushed fragments.

D. Oilbound Macadam Surface Course.—This type of surface course developed by the Pennsylvania Department of Highways has been used extensively in the construction of the Rural Road System.

A specified grading of ¾-in. commercial stone is spread so that a two-inch compressed depth is obtained. After the stone has been rolled from seventy-five hundredths to one gallon per square yard of bituminous ma-

terial is applied in two applications. Either asphalt cut-back or coal tar or water gas tar complying with our specifications for Class C Specification 1, Class D Specification 2, or Class D Specification 3, respectively is used. The first application is from five-tenths to seventy-five hundredths gallons per square yard after which the surface is rolled with a ten-ton roller to a uniform cross-section and allowed to dry from twenty-four to thirty-six hours. The second application of bituminous material is made at the rate of twenty-five hundredths of a gallon per square yard. Immediately following this second application of bituminous material there is uniformly spread twenty pounds per square yard of ½-in. commercial size stone followed by rolling until the surface is thoroughly compacted. The quantity of bituminous material used in the first application is dependent on obtaining thorough penetration without excess.

The bituminous material is spread evenly in both applications by an approved pressure distributor. The length of the road surface penetrated with bituminous material is gauged by the facilities for handling, dependent upon labor and equipment on the project, special attention being given to compression and spreading.

On rural roads near urban centers where heavier traffic is carried it is necessary to construct higher types, such as surface treated macadam, bituminous penetration macadam or bituminous concrete.

Where bituminous concrete is considered necessary we have found it more economical to use those mixtures of the so-called cold-laid type.

It is our intention in addition to the above to construct surface course of the retread type, in which we shall probably utilize asphalt cut-backs, tar cut-backs and asphalt emulsions for comparison.

The asphalt emulsion which will be used for this work will comply with department specifications for asphalt emulsions, Type D.

The bituminous materials which may be used for retreatment of bituminous surface-treated macadam are either asphalt cut-backs Class C Specification 1, coal tar Class DH Specification 2, water gas tar Class DH Specification 3, or asphalt emulsion Type C. The asphalt cut-backs and tars are applied at the rate of twenty-five hundredths of a gallon per square yard, subsequently chipped with twenty-five pounds per square yard of ¾-in. commercial size stone and rolled. For initial treatment of bituminous surface-treated macadam we use either coal tar Class DL Specification 2, or water gas tar Class DL Specification 3. The tars are applied for a total of five-tenths of a gallon per square yard in two applications followed by twenty pounds of commercial ¾-in. stone and rolled.

As to surface courses, we find that a bituminous coated, broken stone pavement, approximately 2 in. in depth properly sealed affords satisfactory results with a minimum of future maintenance cost. These surfaces vary from 2-in. penetration to a 2-in. mixed in placed retread. Most of them are at least dragged for the purpose of smoothing and coating the aggregate. Heavy surface treatments have also been used with good success, being dragged for the same purpose as stated above. The lighter surface treatments on the various types of base courses may be economical as to first cost, but require more frequent surface treatment and do not appear to be as good an investment as the heavier surface courses.

Our experience with low-cost construction, carrying light-motor vehicle traffic under modern conditions, while brief, is very gratifying.

Pennsylvania has taken the first step forward in a new era of highway development. With its main state highway system of 13,000 miles of inter-county and intra-state roads practically completed and the additional 20,000 miles of rural roads demanding surfacing, a different type of improvement program is required, no longer consisting solely of high-type construction on heavy traveled routes. Roads are still being built to meet traffic requirements, but these requirements are necessarily lower with a resultant increase of flexible type pavements.

The department is faced with the responsibility of maintaining and constructing 33,600 miles of state highways, as well as meeting the interest and sinking fund requirements on $100,000,000 worth of highway bonds and paying the expense of the operation of the motor patrol and the Bureau of Motor Vehicles in the Department of Revenue. In spite of this increased responsibility the first two fiscal years of the new system will see the completion of over 8,200 miles of rural highways as well as over 2,000 miles of the original state highway system and the adequate maintenance of the entire system without any increase in highway revenue and with practically no increase in the overhead cost of operating the department.

Acknowledgment.—The foregoing is a paper presented Sept. 14 at the 20th Annual Convention of the Canadian Good Roads Association.

States Spent $955,000,000 for Highways Last Year

State highway expenditures in 1932 amounted to $955,446,000 according to information collected from state authorities by the Bureau of Public Roads, U. S. Department of Agriculture. Of this amount $816,765,000 was expended for construction and maintenance of highways, interest on bonds and notes and miscellaneous expenses. These items represent the capital investment and current expenses on account of state highways. Other disbursements such as principal payments on bonds, transfers to local road authorities and obligations imposed by statute totaled $138,681,000.

Maintenance of the state systems which include 358,210 miles of main highways, gave employment to from 130,000 to 160,000 men throughout the year. States surfaced 29,500 miles of road and more than 6,000 miles were graded. The direct employment furnished by this construction was 86,000 men in January. This rose to 215,000 in September and was 144,000 in December. For every man directly employed it is estimated that two others were indirectly employed in supplying and transporting materials and machinery.

Total funds available were $1,173,576,000, consisting of $275,259,000 balance from previous year, $632,200,000 current revenue from state sources, $161,467,000 Federal and local contributions, and $104,650,000 from sale of bonds and notes. More than 90 per cent of the current state revenue was derived from motor vehicle fees and gasoline taxes.

CIVIL SERVICE EXAMINATIONS FOR ENGINEERS ANNOUNCED.—The U. S. Civil Service Commission, Washington, D. C., has announced competitive examinations for the following positions: Senior engineer, $4,600 to $5,400 per year; engineer, $3,800 to $4,600; associate engineer, $3,200 to $3,800; assistant engineer, $2,600 to $3,200. The duties will be to perform, or supervise the performance of, engineering work in design, construction, survey, research, and/or investigation in one of the branches of engineering listed below: (1) Aeronautical, (2) Agricultural, (3) Civil, (4) Construction, (5) Electrical, (6) Heating and ventilating, (7) Highway, (8) Mechanical, (9) Mining, (10) Radio, (11) Structural, (12) Telephone.

SNOW REMOVAL SECTION

DRIFT PREVENTION — SNOW REMOVAL

Street and Highway Clearing

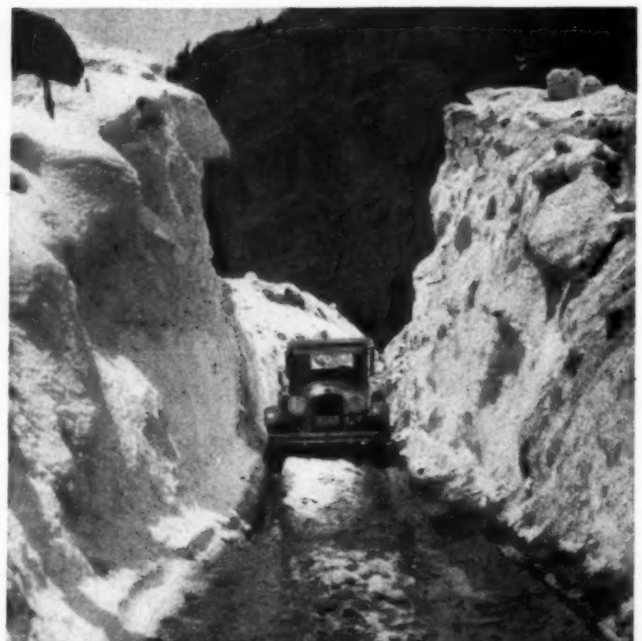
Snow Removal and Winter Road Maintenance in Ontario

By W. L. SAUNDERS

Resident Engineer, Department of Highways, Ontario, Port Hope, Ont.

WE will classify the roads to be dealt with in this discussion as gravel roads and paved roads.

Generally speaking we would recommend that gravel roads should not have the snow removed to accommodate winter traffic, due to the fact that most of our roads of this class have a comparatively thin coat of metalling and when cleared of snow the frost penetrates to a considerable depth. If the snow is removed it should be pushed off the shoulders into the ditches wherever possible, well in advance of the time when the frost starts to come out. If this is not done the frost is retained in the shoulders after it has started to come out of the traveled portion of the highway, and as the water in the center is unable to escape to the ditches, the highway becomes impassable. Where it is found desirable through demands of traffic that a gravel road should be kept open, it would, we think, be very advisable to carry out a program of gravel surfacing in the fall after the tourist traffic has fallen off. It would also be advisable to have stock piles of gravel or crushed stone handy to sections which are known to be bad in the spring, and these piles should be made as high as possible as the material will probably be required while the surface of the piles is still frozen.



This Is Not an Ontario Drift. A Slide from a Colorado Mountain Covered the Road for a Distance of 2,000 Ft. At the Deepest Point It Was 45 Ft. from Road Bed to Top of Snow

Proper Fall Preparation Prevents Bad Spring Conditions.—In considering the whole problem of winter maintenance, we must keep in mind that to avoid paying the penalty of bad conditions in the spring we must be well prepared before freeze-up. This necessitates the careful cleaning of all ditches and culverts to permit of a free run-off in the spring freshets.

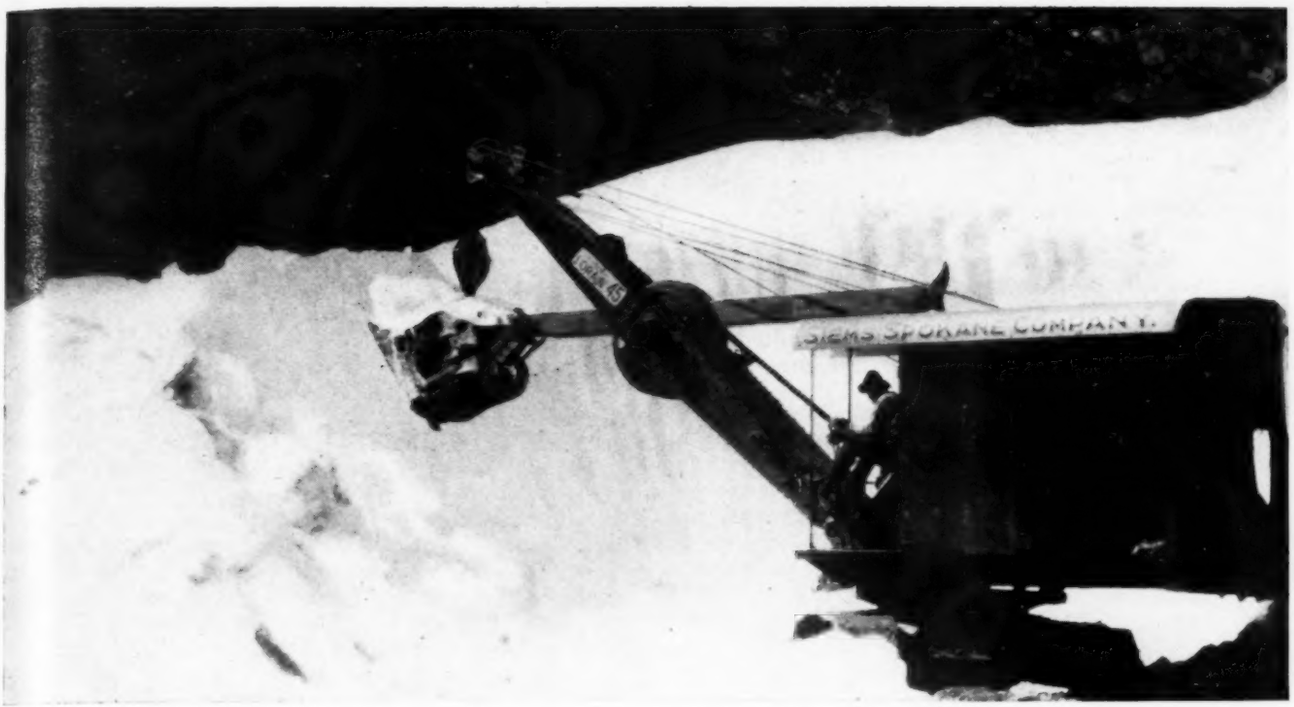
As the condition of the gravel surface is liable to prevail throughout the winter months, it is necessary to impress on those responsible to have the surface as smooth as possible at the time the surface becomes frozen and dragging operations have to cease. We have found it possible on some of our roads to create a little more crown than usual previous to the road freezing and where this can be done we believe it to be a desirable practice.

Even on gravel roads where it is not intended to keep them open it is still important to make every preparation in the fall to facilitate the most perfect spring conditions possible, and whether or not the road is kept open for motor traffic, it is equally important that so far as possible measures should be adopted for the prevention of snow drifting.

Drift Prevention.—Due to the demands made by the owners of both cars and trucks, the Department of Highways, Ontario, has been obliged to increasingly extend its winter maintenance programs, until at present time, there is either a complete or modified policy of snow removal on almost all its highways. I think the erection of snow fences is probably the most important measure adopted for the prevention of drifts, and through the effective legislation adopted and revised during the past 18 years, highway officials are enabled to erect fences wherever it is deemed necessary with a minimum of interference from property owners. Property owners are protected against loss through crop damage and are compensated when any such damage occurs. We would refer anyone interested in the legal aspect to "The Snow Roads and Fences Act," Revised Statutes Ontario, 1927, C. 254.

The form of fence, used almost entirely in this province, is that made of the ordinary commercial lath of good grade, woven by machine with galvanized wire into rolls 100 ft. in length. These rolls can be conveniently handled by two men. As there may be some variation in the quality of fence it would be well for purchasers to obtain samples and insist on the delivered fence conforming thereto. In localities where there is a particularly heavy snowfall, fence may be obtained at a slight extra cost of a greater height than the regular 4 ft. type ordinarily used.

Erection of Snow Fence.—As soon after the 15th of November as convenient workmen may set standard steel fence posts in the ground at the locations where it is



This Slight Snow Fall Occurred in Alaska. The Power Shovel Was Used to Make the Highway Passable

intended to erect fence. These generally would be located at intervals of a rod apart in line and a distance of about 100 ft. from the center of the road. As a rule the ground will be frozen before there is sufficient snow to drift and if possible the fence should not be hung on the posts until the ground is frozen, when the workmen will be able to drive close to the point of erection with either teams or trucks.

In erecting the fence we are of the opinion that 12-gauge soft black wire is about the best grade for hanging the fence on the posts. This is purchased in rolls and can be easily cut with pliers in convenient lengths. It is also pliable and strong enough to permit of being twisted quite tight. The fence is kept off the ground about 4 inches and placed on the windward side, it being advisable when driving the posts to lean them slightly into the wind.

Once the fence has performed its function of creating a drift it could be removed from the original posts and reset on another line farther back if an excessive amount of drifting is taking place, it being only necessary to have the additional posts in case the first line are frozen in to such an extent that they cannot be pulled.

Hastening the Melting of Drifts.—In order to minimize the possibility of damage to crops, it would be advisable where this is liable to occur, to have men go along just after the snow has started to thaw and dig holes in the drift at intervals of about 25 ft. This practice will accelerate the disappearance of the snow. Wherever possible the fence should be removed in the spring as soon as further drifting is not liable to occur and while the ground is still frozen, in order that the vehicle used for handling it can drive in the field. When taking down the fence the workmen should be careful to collect all wire which was used for hanging the fence, as otherwise it might cause damage to the farmers' implements later on. The fence on being taken down can be placed in small piles either on the side of the highway against the fence adjacent to where it is erected, or where it can be arranged with the property owner in the case of pasture, the fence can either be left standing or piled on the field side of the fence. We have found it possible to make these arrangements in a number of cases.

Planting Evergreen Barriers.—Just while we are dealing with the matter of drift prevention, I should like to bring up and possibly have discussed the advisability of acquiring sufficient extra right of way at points where drifting occurs and the planting of evergreen barriers, which could be maintained at a suitable height for the purpose. The space between this barrier and the normal limits of the highway could no doubt be put to many useful purposes during the summer months either as garden plots, tourist camp grounds or other uses. I believe that if some thought is given to this, that it will be found in many cases that the cost of acquiring this extra right of way and the erection of the barrier would be very little more than the initial cost of the snow fence, posts and one year's erection and taking down of same. I have been unable to get any data on instances where this practice has been adopted, but probably bringing up the point at this time may lead to someone giving us the benefit of their experience in this connection. I think the acquirement of the extra right of way in many cases would be a matter of convincing the property owner that an acre of land at the back of the farm is just as good as the fifty foot strip along the front, and I believe that in many cases the proposal which I have made would in many cases be a distinct improvement to the appearance of the adjacent property.

Snow Removal.—In some sections the liberal use of snow fence makes it a rather simple problem to keep the highway free of snow, at least to the extent that it interferes with traffic, but this province at least has found it necessary to adopt quite an extensive program of snowplowing to satisfy the demands of the ordinary motoring public, as well as the ever increasing transport business.

During the past winter the mileage of King's highways to be kept open for traffic was divided into 35 sections, 27 of which were on a contract basis, seven looked after by department of highways equipment, and the

heavy section around Ottawa jointly by a contractor and a department plow. We believe the specifications for snow clearing as used by the department of highways of Ontario during the past winter were most satisfactory both from the standpoint of the department and the various contractors. In this province there are quite a number of contractors equipped with heavy trucks which are very suitable for snowplowing, and as they would otherwise in most cases be out of commission during the winter months, it is quite advantageous to employ as many as possible during the winter.

All plows used by the department of highways in Ontario are owned by the department, those used by the contractors being of the V-type. On the sections where snowfall is the heaviest the department have heavy motor trucks of their own capable of driving a rotary plow if necessary, these being kept available and readily interchanged with either a blade or V-plow as required.

We have also found it advantageous to have some of our lighter trucks equipped with a blade either mounted in front or under the truck. These light trucks can handle very well a light snowfall which if not removed might cause very bad ice conditions and they handle such a situation much better than do the large trucks with V-plows.

One of the most difficult problems in connection with snow removal is to do it in such a way that both sleigh traffic and motor traffic may be served.

Providing for Sleigh and Truck Traffic.—Where the snow fall is not too heavy it is possible to keep sufficient snow on the shoulders of the road to provide a sleigh track, in which case the center of the road should be quite clear of snow to be safe for motor traffic. Where there is a considerable amount of snow the plow should leave sufficient snow on each side of the traveled surface to accommodate sleighs, as the snow banks on each side will act as a protection for motor traffic if the snow becomes smooth. We believe that if transport companies in particular would be a little more reasonable in their exacting demands for winter conditions, that sleigh traffic could be given a little fairer break in many cases. Unfortunately some transports insist on being given conditions in the winter whereby they can attain the same speed as in the summer. As there are still quite a number who wish to or must use horse drawn vehicles, this dual demand may necessitate new requirements to cope with it.

In the successful operation of snow plows nearly as much depends on the truck driver as on the truck itself, and on the ability of the operator to not only make a track through with this plow, but to leave the road in such a condition that after a succeeding storm this work will be facilitated. Most operators do not use the wings to the extent they might, the common failing with most of them being that they set the wings on an angle instead of horizontally. The operator should endeavor to leave a berm or shelf near the top of the bank which provides a place for a succeeding storm to pile the snow, and if this is not done the storm will fill the cut and create a difficult situation.

The specifications for snow clearing as compiled by the department of highways of Ontario pretty well assure the procuring of suitable trucks for the purpose, and it would probably be not out of place to deal briefly with some of the clauses included therein.

Ontario Specifications for Contract Work.—Trucks are to be in good condition and must be approved by the department, this implying an inspection by a qualified motor mechanic. Contractor to supply drivers for each truck and must also be prepared to operate truck continuously day and night, Sundays and holidays, if required. Drivers shall be relieved at the end of ten hours. The department will supply a helper for each truck driver, the helper being directly responsible to the resident engineer for the proper operation of the plow, and also for the keeping of a diary and record of the plow operations. Contractor to supply gasoline, oil and repairs to his own truck. Department will maintain the snowplow. Contractor must furnish, with his tender, a bond covering all public and personal liability and in addition the department will retain a lump sum of $300.00 until all outstanding accounts are paid. Contractor to supply his own heated garage, preferably at either end of his beat. Drivers must be available by telephone. The contractor will be paid a flat rate per day of 24 hours for the supply of truck, driver, together with storage accommodation, and in addition he will be paid a tendered price per hour for the actual time worked. The payment of the contractor will only be made if his truck is in proper repair and able to operate. The contractor shall be required to work on any section other than the one on which his tender is accepted, when so ordered by the department and when so doing shall be paid his tendered rate per hour, and in addition shall be allowed actual expenses of his driver and stabling of truck when off his own section.

A Rotary Truck Plow Clearing the Way on a Pennsylvania Highway

The department supplies suitable storage for their own plows and trucks and make every provision for their drivers being available at any time, night or day, the department being particularly fortunate in having truck drivers available who have been engaged in driving snowplows for several years past.

In concluding my remarks on the matter of snowplows, it is my own opinion that if snowplows get started as soon as the first indication of a blockade is evident and are kept in an efficient working condition that the V-type plows at present in use can cope with most of our snow conditions, it being necessary to only have rotary plows available to assist in the worst storms. As we have found from previous experience that comparison of various types of plows is not advisable we should prefer not to carry this part of the subject any farther.

Ice Conditions.—In sections of the province where there is not a very heavy snowfall there is liable to be just sufficient to either thaw and form ice or merely pack under traffic and become very smooth, either of which is very dangerous to traffic. It so happens in this province that the heaviest traffic both passenger and truck is in the region of lightest snowfall, and the cost of winter maintenance therefor is really heaviest in the sections where there is the least snow, along with cold weather.

In other parts where there is sufficient snow to create banks on the side of the road the ice conditions do not appear to be of much concern, probably the banks having a good moral effect on the drivers of motor vehicles, but in sections where the snowfall is light, the demand for sanding of the highways has become very insistent and this is now one of our most serious and expensive problems. In some sections we have seen an ice condition created on a long stretch of paved road inside of half an hour that resulted in a great many trucks landing in the ditches before our patrolmen were even aware of the condition having come about. We consider that under such circumstances both truck and car owners should be reasonable in their demands for the alleviation of such a condition, as very frequently the condition comes about during the night and disappears as soon as the sun comes out in the morning.

To cope with ice conditions, we arrange with the highway traffic officers and with certain other kindly disposed parties to get in touch either with the resident engineer or direct with our patrolmen as soon as they are aware of the fact that ice conditions require attention.

Use of Calcium Chloride with Sand.—In the fall we establish stockpiles of sand at convenient locations along the highway, and at the time the sand is placed in the pile we add about 30 to 40 lbs. of calcium chloride to the cubic yard. This performs the double duty of keeping the sand from freezing and making it adhere to the dry ice when spread.

Spreading of the sand, which until recently was done by hand casting from trucks, is now greatly facilitated by the use of a simply constructed lightweight mechanical spreader that is attached behind a truck, the hopper of which is kept filled by men on the truck as it drives along.

In spreading the sand on the road it should only be necessary to apply to a width of about 6 ft. down the center, this leaves the sides suitable for what sleigh traffic there may be, and the small quantity of calcium chloride in the road soon causes the center of the road to become clear. At railway crossings it is advisable to sand the right hand side of the surface approaching the crossing, and at this point I would like to mention the necessity of all employes both on snowplows and other operations taking every precaution against leaving snow, ice or other materials on railway crossings.

While the department is doing everything it can to

NEW

Good Roads Champion Model 31 Snow-Plow

1. High-speed, One-way Mouldboard, special funnel—curvature for maximum efficiency.
2. Adjustable Plowing Angle for varying snow conditions.
3. Safety trip feature.
4. Supported on 10" diameter roller-bearing, full swivelling castors, adjustable for edge wear.
5. Oscillating feature to suit road contour.
6. Underframe attachment to truck chassis.
7. Hydraulic Lift.
8. Twenty years of experience behind it.

Good Roads Machinery Corp., Kennett Square, Pa.

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make the highways safe for traffic under very difficult conditions at times, it is still up to the traveling public, and as pointed out before, more particularly transport drivers to observe the triple rule as enunciated by the Minister of Highways of care, courtesy and common sense.

In connection with the damage done to paved roads during the winter, we believe that a great deal of the spawling observed at transverse cracks in concrete is caused by the use of chains on the wheels of trucks. I have personally seen holes gouged in solid concrete to the depth of an inch by the action of wheels skidding with chains on. Late use of crack filler in the fall will help considerably in the protection of cracks in concrete from spawling.

Road Surface Maintenance.—In some cases during the winter we have trouble with concrete pavements developing local heaves or in other instances depressions. Some of these we have found to be recurrent each winter, disappearing entirely in the spring. If such conditions become serious we have found that we could make temporary repairs by heating cold patch material sufficiently to be able to manipulate it, the results being fairly satisfactory especially if able to do the work on a mild day. The use of this cold patch material makes it easy to remove it again in the spring if necessary.

While we have had some cases of boils on asphaltic macadam surfaces, they appeared to be so flatly domed as not to seriously affect traffic, and as they occurred when the frost was starting to come out they soon flattened out to their original level.

In some of the older types of macadam, particularly some of the surface treated waterboard macadam, the breaks during the spring frequently were quite serious and in most cases we found the most effective remedy to be the digging out of the road where the break occurred and the laying of a stone drain to the ditch, backfilling the whole with stone.

Gravel roads, of course, present the greatest problem during the period when the frost is coming out, and the condition of frost boils is a very difficult matter to deal with. We have noticed in some cases the practice was resorted to of piling in a quantity of very coarse gravel or even field stones. This method we cannot personally agree with, as after the road has dried up all the material is surplus and will either have to be removed or if left will create a very undesirable summer condition.

When a gravel road has actually broken up we have found it advisable, where the condition has not been too extensive at one point, to have the mud and water slushed out with a scraper, the material being piled on the outside of the ditch if possible. After the hole has been dried up in this way fresh gravel, even if course, can be put in and when the surface dries out there will be no objectionable bump or surplus of material, and the excavated material can be used to advantage on the adjacent shoulders.

Where a gravel road breaks up the condition may be prevented from recurring by the installation of herringbone tile drains, backfilled with crushed stone or coarse gravel. These herringbone drains in most cases would have to have outlets into parallel drains placed below the frost table if possible. It is our opinion that parallel drains alone, are not effective in the prevention of spring breakups.

Acknowledgment.—The foregoing is a paper presented Sept. 14 at the 20th Annual Convention of the Canadian Good Roads Association.

A Size For Every Motor Truck

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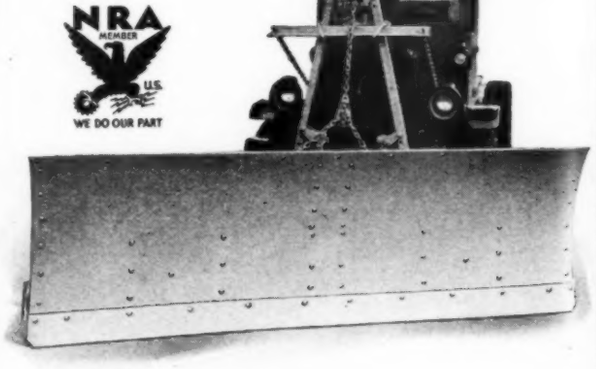

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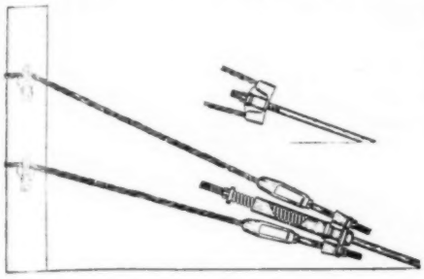
New Equipment and Materials

New Anchors for Highway Guard Cable

Two new anchors for highway guard cable have been added to the line of the Malleable Iron Fittings Co., Branford, Conn. One of these is the equalizing take-up shown as the bottom illustration in the



Two New Cable End Anchorages

accompanying cut. This is being used with compensating spring unit to hold cables taut at all seasons automatically. The other new unit is the cable socket anchorage shown as the other illustration in the cut. The compensating spring unit also is furnished with this type if desired. Both these units are tested with wedge type socket fittings to give an ample margin of safety over the 13,000 to 15,000 lb. cable for the Malleable Iron Fittings Co. Economy design and over 20,000 lb. cable for the Heavy Duty design.

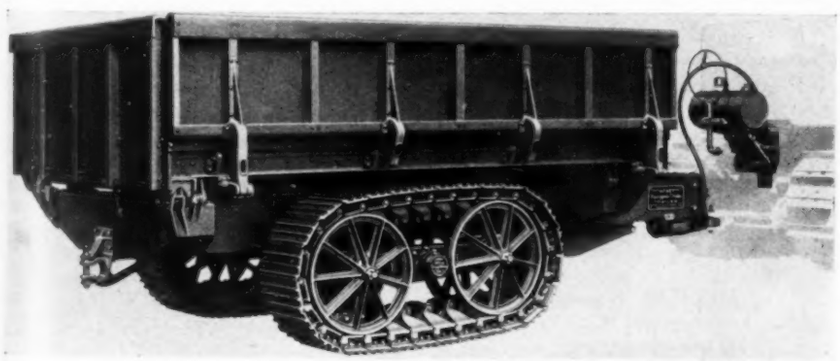
▼

New 2-Way Dump Trailer

A new Athey forged-trak 2-way dump trailer has just been announced by the Athey Truss Wheel Co., Chicago, Ill. This new 2-way trailer is made in two capacities: 9-yd. (10-yd. rounded load) adapted to "Caterpillar" Fifty and 12-yd. (13-yd. rounded load) adapted to "Caterpillar" Seventy Five. Outstanding features are the down-folding side gates that dump to right or left. These side gates down-fold automatically during the first 18 degrees of the 53-degree dumping angle, providing unrestricted discharge of mixed or sticky materials.

Exceptionally low loading height in the new Athey 2-way reduces loading time to a minimum, thus the center of gravity of body and load are also exceptionally low, producing great stability in dumping over soft fills. There is maximum water level capacity, with reduced overall width in order to facilitate passing on narrow cuts and fills. The trailer is an all-purpose unit, equally adapted to hauling sand, earth or rock. Material may be windrowed or spread in layers.

The forged-trak wheels are standard on the Athey forged-trak 2-way dump trailer, providing lighter running qualities that assure substantial savings in fuel, oil, and maintenance of tractor equipment.



New Athey 2-Way Dump Trailer

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A New Lubricant

A new lubricant has been developed in which metallic lead is the protective element. The lead has been broken down into such finely divided parts as to be virtually a soluble or liquid lead within a lubricant vehicle. The new product, known as Bestolife, forms a thin protective film of lead on all contacting surfaces which changes such surfaces to a continuous, unbroken, anti-frictional area, according to the manufacturers, Armite Laboratories of Los Angeles. The lubricant has a pure metallic lead base instead of lead salts and is said to be free from chemical reactions. The minimum constituency of lead in Bestolife is 10 per cent, ranging up to 65 per cent, and is claimed to withstand temperatures up to 430° and will not entirely lose its lubricating stability until the melting point of lead is reached, which is 590°. The principal application of the product in the road and street field is for use as a gear lubricant, also for bearings, wire lines, pipe threads, pump and valve stem packing and brake band dressing. The manufacturers have issued a bulletin. Copies may be had by addressing Armite Laboratories, 1450 East 61st St., Los Angeles, Calif.

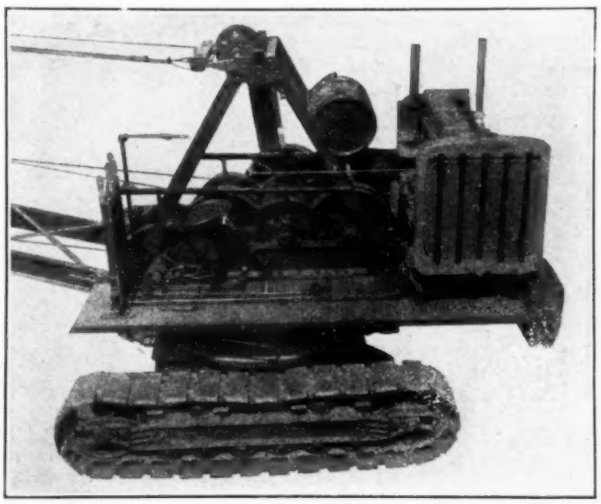
▼

New Light Weight Convertible Diesel Shovel

A new light weight low priced convertible full Diesel shovel has recently been introduced by the Speeder Machinery Corporation, Cedar Rapids, Ia.

The Speeder D4, as the Diesel model is known, is rated at ⅝ yd. capacity for shovel, crane, dragline or pullshovel work. Crane and dragline booms are 35 ft. in length, the shovel boom is 18 ft. long and the dipper stick 14 ft. in length. As a shovel it is equipped with either a standard speeder bucket for bank or subgrade work or manganese bucket for rock work.

The Speeder D4 is powered with a "Caterpillar" diesel motor and weighs only 15 tons. Upon the machinery deck is found many improvements over former Speeder models but the same long proven type of construction is followed throughout.



New Speeder Light Weight Diesel Powered Shovel

The extreme simplicity of the mechanism of the Speeder D4 is evidenced by the fact that there are only nine spur gears in the entire machine and every working part is accessible without dismantling. Shafting has been increased in diameter, gear faces have been increased, a Morse lubricated silent chain 5 in. in width and only 34 in. in length from center to center transmits the power from the motor to the mechanism. The travel gears are heat treated and run in an oil bath. The crawlers are of the new Speeder lug driven friction free type.

All shafts are dead end, no shafts revolve in the drums, thus allowing both shaft and drum to stop the minute their specific function is performed. The economy of this feature is obvious. The illustration shows the Speeder D4 with cab removed.

A New Scarifier

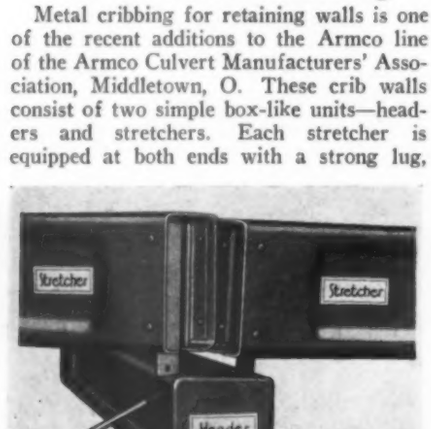
A new scarifier having an auger like cutting action has been brought out by Moritz-Bennett Corporation, Effingham, Ill. The cutting tool is a spiral so designed that

Moritz Chinese Spiral Scarifier

when in rotating contact with the ground surface it digs into the material, cuts it off, "chews it up" and turns it over and mixes. The auger like action is stated to enable it to cut into tough treated or untreated surfaces. The depth of cut is regulated through mechanical controls. The length of the equipment, excluding tractor hitch, is 12 ft. The extreme width is 7 ft. and the approximate shipping weight is 4,800 lbs. The diameter of the spiral is 18 in.

Armco Metal Cribbing

Metal cribbing for retaining walls is one of the recent additions to the Armco line of the Armco Culvert Manufacturers' Association, Middletown, O. These crib walls consist of two simple box-like units—headers and stretchers. Each stretcher is equipped at both ends with a strong lug,



Shows Triple Bolted Construction of Cribbing Joints

which fits into a corresponding slot in the header unit where it is securely bolted. Every header is in turn locked at opposite ends to the stretchers directly underneath by two bolts placed vertically through the lugs which extend on either side of the header unit. By using different combinations of these header-stretcher units it is possible to build continuous or staggered walls of almost any dimension.

The headers and stretchers are available in 4, 6 and 8-ft. lengths, for different service conditions. Each unit has virtually the same dependable strength as a structural I-beam 1½ times its entire weight. One man can manage two of the units at a time, and the cribbing can be erected by unskilled workmen without the use of derricks or cranes at any stage of the job. The units are made of Armco ingot iron.

Continental Roll & Steel Foundry Co. Now Making Trailbuilders

Wooldridge Trailbuilders, long established in the National parks, Forestry service, and western lumber camps, are now manufactured and distributed by the Continental Roll & Steel Foundry Co., East Chicago, Ind. The first Continental-built machines, now in production, are trailbuilders for the McCormick-Deering T-40 TracTracTors.

The Continental Roll & Steel Foundry Co., operating steel plants at East Chicago, Ind., Wheeling, West Va., and Pittsburgh, has established an Industrial equipment division for merchandising heavy tractor-operating equipment. Sales offices have been opened at 332 South Michigan Ave., Chicago, for the Industrial Equipment Division. R. W. Moon, well known in the tractor equipment field, is manager of the division. It is understood that the Continental Company will also merchandise Wooldridge equipment for the Allis-Chalmers, Caterpillar and Cletrac tractors.

Continental-built equipment combines the new dynamic steel with the high-quality welded construction characteristic of Wooldridge machines. Dynamic steel is a recent Continental development in steel alloys. It is described as steel that will stand up under tremendous and continuous shock. This "stamina" steel is especially adapted to dirt and rock moving equipment operating with crawler tractors.

Wooldridge Hydraulic Trailbuilders have established distinctive records of low-cost work. That is due in a great measure to the ease of maneuvering the blade. The Wooldridge blade is powered both up and down and also adjustable to many horizontal angles. These adjustments are invaluable in starting a trail or road in hills and mountains. The Wooldridge hydraulic pump is a gear oil pump operating at low pressures and supplies oil through a 4-way valve. This valve is readily responsive to the operator, which, in conjunction with the rear adjustments of the rocker arm, eliminates all lost time in maneuvering the blade.

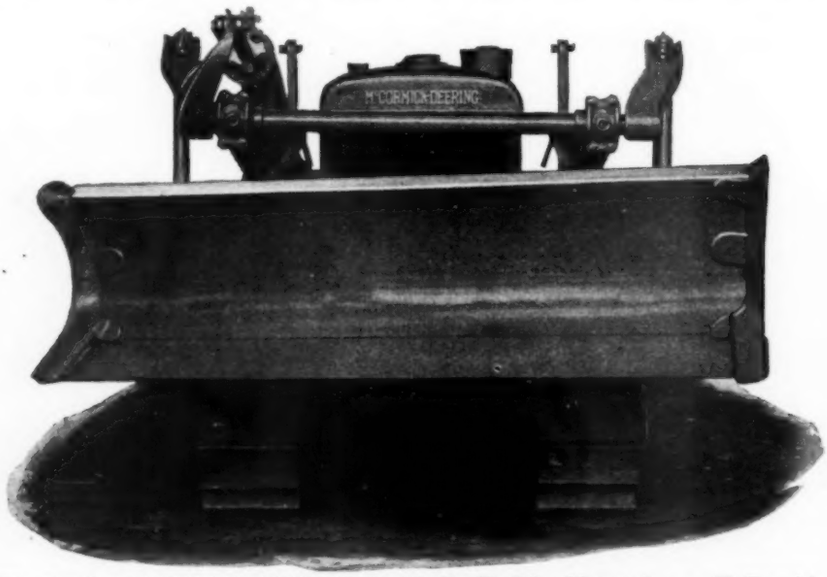
The Trailbuilder is an angling blade that can be used either side or operated as a straight blade bulldozer. Combining Continental materials and manufacturing facilities with Woolridge design establishes the distribution center of these popular machines accessible to the middle west and eastern territory.

New Hydraulic Western Bulldozer

Weighing approximately 1800 lb., but capable of resisting great strain, this simplified bulldozer (of few parts) with high lift and very low undercut is built to match the full power of a Cletrac 35, according to The Austin Western Road Machinery Co., Chicago. Bulldozer is very simple to attach, and may be removed or replaced quickly and easily; blade and push beams can be removed in a few minutes.

Adaptability of Cletrac Tractor for drawbar work is never impaired; turning clearances are not restricted in the least; oil pump is mounted out of way behind driver's seat in position of power take off.

Blade can be raised or lowered to any position and held rigidly or it can be



The Continental-Built Wooldridge Hydraulic Trailbuilder Mounted on a McCormick-Deering T-40 TracTracTor

New Western Bulldozer

allowed to float; tilt of blade can also be varied. A highly efficient gear pump provides smooth, positive manipulation. Pressure is applied to blade in both directions. Lever operating four-way valve provides finger-tip control. Heavily reinforced blade rolls material instead of pushing a dead load ahead. High carbon steel bit is reversible to provide double wear. Shoes of wear-resisting alloy steel have replaceable soles.

New Snow Plow

The Good Roads Machinery Corporation, Kennett Square, Pa., has announced an important addition to its complete line of Good Roads Champion plows. The new plow will be known as Model 31 and is a one-way high-speed plow designed for use on 1½ to 2½-ton trucks. Important features of this plow are a mouldboard properly shaped with a special funnel curvature to give maximum results with a minimum of effort and strength on the motive power; a semi-circle providing adjustment of the plowing angle to suit varying snow conditions; the trip feature to prevent damage to plow or truck when encountering an obstruction, and an oscillating feature to suit the contour of the road surface.

Good Roads Model 31 Snow Plow

The plow is carried on 10 in. diamond roller-bearing full-swivelling castor wheels made of extremely hard alloy steel and readily adjustable to compensate for wear on the cutting edge. These wheels relieve the truck from a great deal of the dead load. The plow is furnished standard with an underframe which attaches to the truck chassis back of the cab so that none of the push load is taken on the front axle. A very efficient hand-operated hydraulic lifting device is furnished with the operating lever in easy access of the truck driver and the services of an extra man to handle the plow are not required.

New Wire Rope Socket

A new socket that makes the socketing of wire rope a simple easy task has been announced by the American Steel & Wire Co., Chicago. The sockets are composed of three simple parts—a socket, a sleeve and a plug. There is no flame needed, nor hot metal to pour. The job may be completed quickly with ordinary labor in the field. The socket gives 100 per cent cable strength. Further details can be obtained from the American Steel & Wire Co., Room 1404, 208 South La Salle St., Chicago, Ill.

A Carbon Black Suspension for Coloring Concrete Highways

A material for tinting or coloring concrete highways, pavements, flooring and architectural concrete has been presented to the highway field by Binney & Smith Co., New York, pioneers in the manufacture and development of carbon black products. This material, known as HiBlak, is an unadulterated suspension, or fluid water dispersion of pure carbon black.

HiBlak has been developed with special reference to road building and for more than a year test panels have given satisfactory performance on a densely traveled road near New York City. During this period extensive laboratory tests have been made. The report of The Haller Testing Laboratories, Inc., New York City, follows:

Materials Data:

Cement:	
Residue	10.3%
Soundness	O.K.
Tensile Strength (1–3 mortar)—	
3 days	310 lbs.
7 days	395 lbs.
Sand:	
Fineness Modulus	2.28
Ottawa Ratio	111.5%
Color	Plate No. 1
Stone:	
Fineness Modulus	411

Note: Above materials tested for quality before use.

Test Results

Compression Strength:

Series	3 days	7 days	28 days
No. 1—No Color (control)	1,015	2,460	3,795
No. 2—8% HiBlak	970	2,395	3,779

Modulus of Rupture (6 in. x 6 in. x 30 in. specimens)

No. 1	815
No. 2	795

Freezing and Thawing Tests (2 in. x 4 in. Specimens—10 Cycles)

No. 1	Not affected
No. 2	Not affected

Toughness Tests

Series	
No. 1	18
No. 2	18

Note: The results of these tests through 28 days indicate no adverse effect on the strength, toughness, or durability of concrete specimens.

It is stated that because of its great color intensity HiBlak can be used to produce a truly black concrete or, for tinting, to develop any desired shade of gray. The fact that it is put up in completely dispersed form assures freedom from specks or spots and guarantees complete uniformity of tone.

For convenient handling on the job HiBlak has been put up in sealed, metal containers, carrying 60 lbs. of HiBlak, which includes 15 lbs. of carbon black on the dry basis. This weight of HiBlak corresponds to a bulk of roughly 6 gal. HiBlak has the consistency of a syrupy liquid and flows quite readily. HiBlak has been designed so that there is a slight tendency to jell which constitutes a definite advantage since this assures continued suspension of carbon black particles and uniformity of the mix. There is no tendency to settle. Furthermore when HiBlak does assume a jell structure a little stirring will quickly bring it back to the fluid form.

To produce a pleasing slate gray color restful to the eyes and eliminating glare on a concrete highway 8 per cent of HiBlak based on cement content on a weight basis has been found to be amply sufficient. With the 2-course type of concrete highway having a 2-inch top layer, tinting by means of HiBlak may be accomplished at a price of about 5 cents per square yard.

HiBlak is extremely easy to handle and can be measured out on the bulk basis because of its non-settling qualities. All that is necessary is that ordinary precautions be taken to make sure that the same amount is added to every batch and the material may then be directly added to the concrete aggregates and mixed in with those in the ordinary course of mixing.

Recent United States Patents Relating to Roads

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AUGUST 1, 1933

1,920,319 **Subgrading Machine.** Theodore R. Regenhardt and Charles Kassel, Cape Girardeau, Mo., assignors to Regenhardt Construction Co., Cape Girardeau, Mo. A subgrader comprising a frame, a series of mold boards supported by said frame for loosening a continuous strip of earth and materials equal in width to the distance from one end to the other end of said series of mold boards, conveyor mechanism supported by said frame for discharging laterally the earth and materials loosened by said mold boards, a motor supported by said frame, mechanism operated by said motor for adjusting said frame and said mold boards in position for opera-

tion and mechanism operated by said motor for operating said conveyor mechanism.

1,920,582. **Traffic Marker.** George Dalton Myers, Cincinnati, O., assignor to The Edwards Manufacturing Co., Cincinnati, O. A traffic marker comprising a metal plate, and a metal pin extending from the plate, said pin consisting of two portions, one of said portions lying within the other portion, forming the end of the pin and extending into the plate, the metal of the other portion of the pin and plate being continuous.

1,920,633. **Machine for Laying Off Surface Contours to Scale.** Charles B. Dannenberg and Harry Whittaker, Wilmington, Del. A machine for laying off road and other surface contours to scale, comprising an elongated substantially rigid member supported for vertical reciprocatory movement and having means upon one end to facilitate its movement in vertical position over the surface to be plotted, a marking element, mechanism coupling said elongated member with said marking element for translating movement at a reduced ratio from the member to the marking element, a chart engaged by and moved relative to the marking element in a path at right angles to the direction of movement thereof, and means for supporting the structure for movement in a horizontal path over the surface being charted.

AUGUST 8, 1933

1,921,081. **Road Reenforcement and Joint.** John N. Heltzel, Warren, O. A stake formed from a flat strip and having a one-quarter twist between its ends, the lower end of the stake being adapted to be driven into the ground, and the stake having a slot in its upper end to receive an elongated joint member so that said joint member will lie in a plane substantially parallel to the lower end of the stake.

1,921,129. **Highway Guard.** Lee H. Miller, Cleveland Heights, O.; Annie G. Miller, executrix of said Lee H. Miller, deceased; assignor to The Armorsteel Roadguard Co., Cleveland, O. In a highway guard rail fabricated from standard structural steel forms, the combination of a plurality of H-beam supporting posts, rail-carrying members secured to said posts, said members being in the form of I-beam sections, and rail members in the form of flat plates carried by said I-beam members, the ends of said rail members overlapping each other on adjacent posts.

1,921,185. **Method and Means for Surfacing Roads.** John N. Heltzel, Warren, O. A joint producing apparatus, consisting of a movable frame over a plastic concrete surfacing structure, a longitudinal blade to be forced into the plastic concrete, the top of said blade projecting above the top surface of the concrete, and means for finishing the concrete movable longitudinally on each side of the blade independently of the blade.

1,921,688. **Attachment for Road Treating Machines.** Daniel Webster McLaughlin, Des Moines, Ia. In a road surfacing vehicle the combination with a scraper blade of a mixing and treating chamber positioned directly in front of the blade, said chambers substantially enclosing material gathered by the blade, and said blade forming the rear wall of said chamber.

1,921,712. **Road Maintenance Machine.** Rufus L. Ward, Irving, Tex. In a road making and maintenance machine the combination including a main frame and a subframe, a motor carried by said subframe, a series of earth cutting elements suspended by said main frame and capable of adjustment relative to the earth, and endless conveyor receiving material dislodged by said earth cutting elements, a second endless conveyor operating at right angles to said first conveyor and whose lower lead is arranged to receive material conveyed by said first conveyor, an inclined trough pivotally secured to said main frame and extending outwardly and upwardly therefrom, means for adjusting the angularity of said trough and arranged to sustain material moved by said second conveyor whereby the same may be deposited at a point removed from said machine, and means for driving said conveyor from said motor.

1,921,822. **Manufacture of Roads, Yards, Aerodromes, and Like Surfaces and Means Therefor.** John Hines, Barnes, London, England, assignor to Braithwaite & Co., Engineers, Ltd., London, England. A road and like foundation structure embodying therein top and bottom spaced layers, each comprising metal plates arranged with the edges of the plates in one layer offset with respect to the edges of the plates of the other layer and a non-metallic filling material disposed between said layers.

1,921,881. **Coupling Device for Road Forms.** Harry E. Holford, Binghamton, N. Y., assignor to Binghamton Foundry & Machine Co. Inc., Binghamton, N. Y. A road form comprising rail sections adapted for end to end coupling, the abutting ends of said sections being formed on a bias longitudinally of the sections, and means on the abutting ends of said sections for drawing said sections into alignment and for locking them in such position, said means comprising a lug on one of said ends and a hook on the other of said ends for locking engagement with said lug.

AUGUST 15, 1933

1,922,338. **Street Sweeper.** George B. Weaver, Springfield, Mass., and William J. Knaut, New Haven, Conn., assignors to Indian Motorcycle Co., Springfield, Mass. In combination a motorcycle provided with a side car including a supporting frame and street sweeping mechanism operatively mounted in said side car frame.

1,922,462. **Street Marker, Construction Form, and Screed.** Jacob J. Tranchell, Portland, Ore., assignor to Highway Form Company, Portland, Ore. A form for roadway construction comprising a series of hardened plastic blocks having a central portion formed with upwardly converging sides, a narrow flat top surfaced to distinguish it from the roadway, laterally extending flanges along its edges forming a base and a support for re-enforcing material, longitudinal bores cast in said central portion and flanges, dowel rods positioned in said bores, said dowel rods being of the same length as said blocks and projecting from one end thereof forming a socket of corresponding length in the opposite end, and lateral openings formed in said central portion adjacent said flanges to receive transverse re-enforcing rods, substantially as set forth.

1,922,584. **Concrete Form.** John N. Heltzel, Warren, O. A curb face form rail having a lower portion to form a groove between a curb and a road slab and having a flange to overlap said slab, said portion extending downwardly from the flange.

Statement of the Ownership, Management, Circulation, Etc., Required by the Act of Congress of August 24, 1912,

Of Roads and Streets, published monthly at Chicago, Illinois, for October 1, 1933.

State of Illinois, County of Cook, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. S. Gillette, who, having been duly sworn according to law, deposes and says that he is the business manager of Roads and Streets and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Gillette Publishing Co., 400 West Madison St., Chicago, Ill.

Editor, H. P. Gillette, 400 West Madison St., Chicago, Ill.

Managing Editor, C. T. Murray, 400 West Madison St., Chicago, Ill.

Business Manager, E. S. Gillette, 400 West Madison St., Chicago, Ill.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

Gillette Publishing Company, 400 W. Madison St., Chicago, Ill.

H. P. Gillette, 400 W. Madison St., Chicago, Ill.

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E. S. GILLETTE,
Business Manager.

Sworn to and subscribed before me this 22nd day of September, 1933.

KITTIE C. WOULFE,
(Seal) Notary Public.

(My commission expires Feb. 8, 1934.)